THURSDAY, MARCH 31, 1892.

A ZOOLOGIST ON DISEASE.

Leçons sur la Pathologie comparée de l'Inflammation faites à l'Institut Pasteur en Avril et Mai, 1891. Par Élie Metschnikoff, Chef du Service à l'Institut Pasteur. (Paris: G. Masson, 1892.)

DR. METSCHNIKOFF has in this volume given a clear account of the general basis of his phagocyte theory, tracing the significance of amœboid cells or phagocytes from the Protozoa upwards through various groups of animals to the higher Vertebrates. He adduces a vast number of facts, many of them new and now for the first time published (with many beautiful coloured figures), others cited from his own earlier publications and from the work of cotemporary observers, to show that inflammation is essentially a reaction of the phagocytes contained in animal bodies to the presence of injured tissue or intrusive particles—a reaction which consists in active movement to the injured spot on the part of the phagocytes, and the ingulfing and digestion by them of the offending matters.

This volume appears opportunely. It will, I venture to predict, be regarded as epoch-making, establishing on a solid basis the theory of phagocytes, first sketched by Metschnikoff about ten years ago,[1] and repeatedly confirmed and elaborated by his brilliant researches. It will enable the biological world to appreciate the theory at its true value as one of the great generalizations of biology, worthy to take rank, after Darwin's theory of natural selection, with Virchow's cellular pathology, and Pasteur's doctrine of the Bacterial origin of fermentations and infective diseases.

It is worth noting (and weighing well the lesson conveyed) that the flood of light which the phagocyte doctrine throws upon the nature and processes of disease is not due to a medical man, nor even to one of those industrious observers of the physical properties of the tissues of the frog and the rabbit, who pursue their researches by the aid of delicate recording drums, balances, and pendulums, and have for some unexplained reason at the present day been granted the monopoly of the ancient and comprehensive title "physiologist."

Just as the penetrating theories of Pasteur, the chemist, on infective disease, were opposed by the medical profession, who regarded a chemist as an intruder in their domain, so the medical pathologists and the more narrow-minded devotees of the kymographion have, to a large extent, opposed, rejected, and attempted to ridicule, Metschnikoff's doctrine of phagocytes. Unfortunately, medical education is too little based on thorough biological training, and in this country the so-called "physiologist," so far from being a naturalist, plunges into the difficult and not very fruitful task of applying the delicate apparatus of the experimental physicist to the measurement of processes occurring in the higher Vertebrata, without ever attempting to gain a competent knowledge of the ultimate structure and vital processes of the series of lower animals. Had our physiologists and pathologists the advantage of even a moderate instruction in zoology, comparative anatomy, and embryology, they would be making progress towards dealing with many of the problems the solution of which they in vain seek to wring from the unfortunate frog and rabbit. Certainly, it is not possible for a physiologist or pathologist with any pretensions to an adequate knowledge of the structure and activities of the organs and tissues of lower as well as higher animals to fail to see the great value of the generalization which brings together under a common term the phenomena of intra-cellular digestion, of embryonic cell-layers, of inflammation, and of immunity to bacterial disease—which "explains" at once the mesoblast of the Echinoderm-larva and the very existence of the colourless corpuscles of vertebrate blood. The man who sneers at "Metschnikoffism,"—that is, the explanation of the phenomena of inflammation and infective diseases in Vertebrate animals by a comparative study of these phenomena in Protozoa, Sponges, Jelly-fish, Worms, Crustaceans, and Mollusks—must be held to be either very ignorant or morbidly prejudiced against zoological studies.

Elias Metschnikoff has been known for more than five-and-twenty years as the most productive and accurate investigator of the embryology of marine Invertebrata, such as the Sponges, Medusæ, Echinoderms, and Worms. The amount and value of his researches in this field had placed him by general consent in the very first rank, by the side of his distinguished fellow-countryman Kowalewsky, when, ten years ago, he was led to direct his attention more especially to the study of the activity of the amœboid corpuscles of the blood and tissues of certain transparent organisms in resisting infection by vegetable parasites; and thence to other questions of a similar nature. Lately he has retired from the Professorship of Zoology which he held at Odessa, and accepted a position giving him the control of an admirable laboratory in the Institut Pasteur in Paris.

Metschnikoff commences his book with the statement: "It is solely in my quality of zoologist that I have decided to deliver these lectures on a subject which belongs to the domain of pathology." Just as formerly, in comparative anatomy, account was taken only of Man and the Vertebrata, so now, our author says, in medicine up to the present time, all the pathological processes which go on in the lower animals have been left out of consideration. And yet the study of these lower animals, which present simpler and more primitive conditions than do Man and the Vertebrates, is capable of furnishing us with the key, as it were, of those complicated pathological phenomena which are most interesting for medical science. Disease and pathological processes have—he reminds us—their evolution, just as Man and the Vertebrates themselves have.

After describing and figuring examples of parasitic infection among Infusoria, M. Metschnikoff gives details establishing the important property of "chemiotaxis"—positive and negative—as characteristic of amœboid protoplasm, selecting the plasmodium of Mycetozoa for special study. He next discusses the passage from uni-

[1] Metschnikoff's comprehensive view of the significance of phagocytes was first made known to English readers by translations of two of his earlier papers, almost immediately after their original publication, in the *Quarterly Journal of Microscopical Science*, 1884. They were entitled "Researches on the Intra-cellular Digestion of Invertebrates," and "The Ancestral History of Inflammation."

cellular animals to the Metazoa, and his embryological theory of the "phagocytella." The reaction of the mesodermic phagocytes of sponges to foreign matters introduced into the substance of these animals is described; and, subsequently, similar phenomena in Cœlentera, Echinoderma, and Worms are cited, and illustrated by original drawings. It is shown that in these Invertebrates the phagocytes attack and invest, either singly or in fused masses, not only inorganic particles, but large parasites, and also intrusive parasitic Bacteria. Thence he passes to organisms—the Mollusca, Arthropoda, and Tunicata—which have a well-developed blood-system. He shows that here, too, there are no special "vascular" phenomena excited by conditions which in higher Vertebrates produce "inflammation," but solely a "phagocyte reaction" or resistance. Numerous cases of infectious bacterial and fungal diseases in Arthropoda are described, and the action of the phagocytes in combating the intrusive parasites by ingulfing and digesting them is demonstrated. Even when we come to the Vertebrates, it is shown that, in regions of the median fin of the tadpole of the Axolotl, an inflammation can be excited which is purely phagocytic, and in which the blood-vessels and their contents take no part.

The peculiarity, however, of inflammatory processes in adult and higher Vertebrata is, that the blood-vessels come into play. The amœboid corpuscles floating in the blood by active movement (of a chemiotactic nature), push their way through the walls of the capillaries (diapedesis) in the region which is infected or injured, and join their forces to those of the tissue phagocytes in investing and destroying the injurious particles.

A detailed study of the leucocytes of the blood and lymph of Vertebrates follows, which are distinguished as (1) lymphocytes, (2) uninuclear, (3) eosinophil, and (4) neutrophil or multinuclear leucocytes. Metschnikoff shows that the two varieties of leucocytes which play the chief part in inflammation—viz. the uninuclear and the neutrophil—are endowed with a marked chemiotactic and physiotactic sensibility, are capable of amœboid movements, and apt to ingulf and to digest various foreign bodies, notably many kinds of living Bacteria. In the Amphibia he shows that the multinuclear leucocytes can transform themselves into the uninuclear form, and become fixed cells of the connective tissue. In Vertebrates generally, uninuclear leucocytes can be transformed into epithelioid and giant cells. What is true of leucocytes is also true of other migratory cells.

The ninth, tenth, and eleventh lectures deal with such topics as the endothelium of vessels, the dilatation of vessels, chronic inflammations—tubercle being taken as a type—serous inflammation, bactericidal power of serous humours and exudations; and the antitoxic property of the serum.[1] A most important and interesting study of the phenomena of resistance to the tubercle bacillus on the part of the giant-cells of the Algerian Rodent *Meriones Shawi* is given in some detail.

The last lecture treats of some previous theories of inflammation, summarizes the facts which serve to establish what Metschnikoff calls the biological theory of inflammation, and repels some attacks recently made on it. The theory is formulated in these words: "Inflammation must be looked upon in its entirety as a phagocytic reaction of the organism against irritative agents—a reaction which sometimes is carried out by wandering phagocytes only, sometimes with the assistance of the vascular phagocytes or with that of the nervous system." The last words refer to the intervention of the vaso-motor nervous centres.

Medicine, says our author in order to gain her assigned objects must make use of knowledge drawn from all less complicated branches of science; and amongst others from that biology which studies organisms in their living state and their natural evolution.

The services rendered will be reciprocal. General biology, he points out, can gain great advantage by embracing in the sphere of its studies the morbid phenomena now relegated to the pathologist. Too often biology finds difficulties in the study of the processes of evolution because the phenomena are presented to the observer in an already accomplished form. To observe with clearness the play of the general law of natural selection, we must study the less stable phenomena, the less perfected organizations—in a word, the phenomena in which natural selection can be observed every day. Now it is precisely the phenomena of disease and the reactions connected with it—the struggle between the organism and its aggressors—which offer the best opportunity for a close study of the operation of natural selection.

It has been impossible to do justice to this remarkable book in a short review. It has the special quality of carrying conviction to the reader's mind by the fact that every assertion is supported by a number of well-chosen observations or experiments which are described with a lucidity and precision characteristic of a man thoroughly familiar with the minutest details of the things of which he speaks. It is to be hoped that it may have, amongst other consequences, that of silencing certain medical "educationists," who deny that zoology is a necessary or useful accompaniment of the chemical and physical study of living things. Its pages contain convincing proof that medicine has gained more real knowledge and practical help from modern zoology than from the elaborate experimentation on higher Vertebrates which is directed by narrow-minded ignorance of the simpler expressions of animal organization.

E. RAY LANKESTER.

[1] I cannot let pass this opportunity of pointing out an evolutional parallel in the history of phagocytes which tends to harmonize to some extent the views of those who insist on the bactericidal and the anti-toxic properties of serum, with Metschnikoff's view that the phagocytes are of prime importance. In the recent debate at the Pathological Society of London, it was pointed out by several speakers that even if it be admitted that the serum and exudations have, in relation to certain special cases, these properties—or rather contain substances having these properties—those substances must be derived from the living cells of the organism, and probably from leucocytes. The parallel to which I refer is that of intra-cellular and cavitary digestion. The alimentary canal of some lower animals is lined by phagocytes, which individually ingulf solid particles of food, and digest them by means of ferments, acids, &c., formed within the phagocytes. A later stage of evolution of the digestive system consists in the discharge by these cells of the food-dissolving substances elaborated by them into the common liquid occupying the cavity which they surround. The food-dissolving substances are no longer found exclusively in the cells, but in the liquid which bathes them. Yet no one ascribes a *special* power to the gastric juice, or hesitates to trace its qualities to the transformed intra-cellularly-digesting cells. So with bactericidal and anti-toxic juices: they must be traced (when their existence is proved) to the modification of the *modus operandi* of intra-cellularly-digesting phagocytes.

TWO BOOKS OF AFRICAN TRAVEL.

Travels in Africa during the Years 1879–83. By Dr. Wilhelm Junker. Translated from the German by A. H. Keane, F.R.G.S. (London: Chapman and Hall, 1891.)

My Second Journey through Equatorial Africa. By Hermann von Wissmann. Translated from the German by Minna J. A. Bergmann. (London: Chatto and Windus, 1891.)

THE first of these two books deals with a part of the period during which the late Dr. Junker carried on his second series of explorations in Central Africa. On his return to St. Petersburg in September 1878, after his first journey to the Egyptian Sudan, he had no intention of paying another visit to that region. Nevertheless, within a year he was hard at work preparing for a similar expedition, and on October 10, 1879, he found himself on board the steamer which took him to Alexandria. With as little loss of time as possible he made for Khartum, whence he started by the *Ismailia*, on January 31, 1880, for Meshra Er-Req, on the Bahr el-Ghazal. This part of the journey was made extremely tedious by the "sudd," or grass-barriers, through which the steamer had to force its way. The vegetation of which "sudd" is composed grows luxuriantly in back-waters; and great masses of it are brought by winds or by flood-waters into the river. These masses may either drift harmlessly with the currents, or coalesce into formidable barriers. Sometimes they become so compact that a steamer cannot penetrate them, and they must be broken up by special apparatus. This is especially the case in the Bahr el-Jebel. In the Bahr el-Ghazal the barriers are troublesome enough, but are not of quite so tough a texture.

At Meshra Er-Req Dr. Junker met Gessi Pasha, who was at that time Governor of all the Equatorial Provinces. The two men had a warm regard for one another; and after a little delay, due to Gessi's numerous engagements, they made an excursion together to Dem Soliman, the most important of the Arab settlements visited by Dr. Junker in the negro lands. Here they parted, never to see one another again, for Gessi died about two years afterwards at Suez. From Dem Soliman Dr. Junker travelled in a south-easterly direction to the territory of Ndoruma, a native chief, who, although rather fickle, was of considerable service to him. In this territory, on the banks of the Werra, Dr. Junker established a station called Lacrima, where he remained about two months. He then proceeded southward, crossing the Welle, and residing some time with Prince Mambanga, from whose territory he went eastward to Tangasi. Before the end of 1880 he was back at Lacrima, which he had left in charge of his companion, Bohndorff. In the course of 1881 Dr. Junker travelled among several different tribes, arriving about the end of the year at the domain of Prince Bakangai from Hawash station. At this point the narrative stops, to be continued, no doubt, in another volume, although on this point nothing is said either by the translator or by the publishers.

So many changes have taken place since 1881 in the regions visited by Dr. Junker that his account of the mutual relations of the native tribes is now, of course, out of date; but that does not in any way diminish the value of his descriptions of their permanent characteristics. He had a remarkable power of winning the confidence and respect of the people, and thus had many opportunities of forming a trustworthy estimate of their intellectual and moral faculties. Upon the whole, the impression they produced upon him was not unfavourable. He seems to have been especially pleased with some aspects of the character of the Mangbattus, his observation of whom enabled him to say that the "tender side" of negro feeling had been called in question unjustly. The women of this tribe hold a relatively high position. They are allowed to take part with the men in public gatherings, and some of them were occasionally able to act as Dr. Junker's interpreters. The Mangbattus have a decidedly artistic faculty, which they display most effectively in the making of iron weapons. They have a kind of knife which seemed to Dr. Junker "unsurpassed for the beauty and originality of its numerous forms"; and their spear-heads "present an amazing variety of types in the size and shape of the barbs, teeth, and tips." They also "display surprising technical skill in the artistic treatment of diverse wooden utensils and earthenware vessels, which, as in all these negro lands, are turned out without the aid of the potter's wheel." Dr. Junker's geographical observations relate to a comparatively small area, but their thoroughness gives them a unique place in the literature of African exploration; and naturalists will read with interest everything he has to say about the flora and fauna of the districts he traversed.

Scientifically, Major Wissmann's book is of less importance than Dr. Junker's. It records his experiences during his second journey through Africa, which was undertaken in 1886, when he was still in the service of the King of the Belgians. His instructions were to open various parts of the interior of the Congo State; to investigate, and, as far as possible, counteract, the proceedings of slave-hunters; and to report on the countries bordering the Congo State towards the south-east. He made in the first instance for the Bashilange country, where he remained for some time, exploring the region and settling various political affairs. In November he left Luluaburg at the head of a caravan consisting of 900 persons, who accompanied him eastward to the neighbourhood of Nyangwe, on the Upper Congo, whence they were taken back to their native country by Lieutenant Le Marinel. At Nyangwe Major Wissmann was detained by Zefu, Tippu Tib's son, but ultimately he was allowed to depart, and reached the east coast by Lakes Tanganyika and Nyassa, and the River Shire.

The most important parts of the work are those relating to the outrages committed by the infamous slave-hunters; but there are also a good many valuable passages in which the author embodies the results of ethnographical study. Among other peoples described by him are the dwarfs whom he met in the primæval forest. They reminded him of portraits he had seen of Bushmen. They were "of a brown-yellowish colour, or rather light yellow, with a brown shadowing." Their demeanour was "timidly modest," and he had to be careful not to touch them, as they were always ready to take to their heels. An agreeable impression was made by the rounded figures, fresh complexions, and graceful, easy, quiet movements of the young, but the old "might literally be called painfully

ugly"—a fact which seems to be due to their poor food and roving life.

Both books are illustrated, and each is supplied with a map. The map accompanying Dr. Junker's volume does not indicate his routes, which the reader, therefore, often finds some difficulty in tracing.

PROFESSOR TYNDALL'S LATEST BOOK.

New Fragments. By John Tyndall, F.R.S. (London: Longmans, 1892.)

WE have here a miscellaneous collection dealing with various subjects—scientific, theological, biographic, and autobiographic. Some of the papers are lectures delivered at the Royal Institution or elsewhere, some are magazine articles, and a few have been added for the present volume.

The personal recollections of Thomas Carlyle will be read with interest, especially the account of his journey to Edinburgh and the delivery of his Rectorial address.

The article on Pasteur sketches with keen appreciation the remarkable series of investigations which, beginning with the optical properties of unsymmetric crystals, were diverted by circumstances to the life-history of microscopic organisms, and the nature of fermentation.

The sketch of the remarkable career of Count Rumford derives increased interest from local information gathered during a visit to the scenes of Rumford's boyhood in New England.

The lecture on Thomas Young contains a vivid delineation of his personal qualities, and, besides tracing his achievements in physical science, gives a very clear and intelligible account of the methods by which he succeeded in deciphering the Egyptian hieroglyphics. In the accompanying narrative, his openness and plain dealing are strongly contrasted with the crafty suppressions of his rival, Champollion, who, being a professional antiquarian, appears to have thought it intolerable that he should be beaten in his own special province by an outsider.

To many readers, the most interesting portions of the "Fragments" will be those which are autobiographic.

An address, delivered at the Birkbeck Institution in 1884, contains a sketch of Prof. Tyndall's early career, first as a draughtsman in the Ordnance Survey, then as an Ordnance surveyor in the field, next as a railway surveyor in the rush of work which sprung from the "railway mania." Here is a specimen of his recollections of that date:—

"Among the legal giants of those days, Austin and Talbot stood supreme. There was something grand, as well as merciless, in the power wielded by those men in entangling and ruining a hostile witness; and yet it often seemed to me that a clear-headed fellow, who had the coolness, honesty, and courage not to go beyond his knowledge, might have foiled both of them. Then we had the giants of the civil engineers—Stephenson, Brunel, Locke, Hawkshaw, and others. Judged by his power of fence, his promptness in calculation, and his general readiness of retort, George Bidder as a witness was unrivalled. I have seen him take the breath out of Talbot himself before a Committee of the House of Lords. Strong men were broken down by the strain and labour of that arduous time. Many pushed through, and are still amongst us in robust vigour. But some collapsed; while others retired with large fortunes it is true, but with intellects so shattered that, instead of taking their places in the front rank of English statesmen, as their abilities entitled them to do, they sought rest for their brains in the quiet lives of country gentlemen. In my own modest sphere, I well remember the refreshment occasionally derived from five minutes' sleep on a deal table, with Babbage and Callet's 'Logarithms' under my head for a pillow."

We next find him as a master at Queenwood College, Hants, where he had Frankland for a colleague.

"Queenwood College had been the Harmony Hall of the Socialists, which, under the auspices of the philanthropist, Robert Owen, was built to inaugurate the Millennium. The letters 'C. of M.,' Commencement of Millennium, were actually inserted in flint in the brick-work of the house."

Having saved some two or three hundred pounds, he went with Frankland in 1848 to study science in Germany, and selected Marburg as a place where he could live cheaply amid agreeable surroundings. Here, if the mists of intervening years have not unduly magnified the past, we must believe that he worked without weariness for sixteen hours a day. There were about three hundred students. Bunsen was the Professor of Chemistry, and appears to have given great prominence to chemical physics. His lectures included the electric telegraph, and a very full exposition of Ohm's law; and in the department of heat he made complimentary references to Joule.

In process of time our student began to make original investigations, and his first paper was on the phenomena of water-jets. It included the remark that the musical sound of cascades and rippling streams, as well as the sonorous voice of the ocean, was mainly if not wholly due to the breaking of air bladders entangled in the water.

After taking his degree at Marburg, he came over to England, but soon returned with his friend the late Prof. Hirst to Germany, where he studied at Berlin under Magnus, and met Dove, Ehrenberg, Mitscherlich, Du Bois-Reymond, Wiedemann, Clausius, Poggendorff, and Humboldt.

The happy associations of University life strengthened the predilections which originally attracted him to Germany, and he professes great admiration for the German character, which, alike in science and in war, aims not at glory, but at the discharge of duty.

Further gossip of an autobiographical kind is furnished under the head of "Old Alpine Jottings," which occupy the last seventy pages of the volume. Here we find him recruiting exhausted nature, after intellectual toil, by arduous climbing on icy slopes, over fearful precipices, and under a fusillade of boulders shooting down from the heights above.

Perhaps the most vigorous piece of writing in the book is that which is placed first—a lecture on Sabbath observance, delivered in 1880 before the Glasgow Sunday Society; and we must not omit to mention the second article, which gives a very full account of Goethe's work on colour. It pays a high tribute to Goethe's acuteness as an observer, but gives an unsparing exposure of his weakness as a scientific theorist.

The volume, though not ambitious, contains much pleasant reading.

J. D. E.

OUR BOOK SHELF.

A Treatise on Chemistry. By Sir H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S. Vol. III. "The Chemistry of the Hydrocarbons and their Derivatives; or, Organic Chemistry." Part VI. (London: Macmillan and Co., 1892.)

THE present section of this well-known work deals with the derivatives of naphthalene and the allied hydrocarbons —phenanthrene, chrysene, &c.; also with the compounds containing two or more benzene nuclei directly united, such as diphenyl.

The extraordinary expansion which this particular branch of organic chemistry has undergone during the last fifteen years is due in part doubtless to the fascination of the various problems of constitution which these compounds offer, and to the well-founded assurance that Kekulé's benzene theory, which had thrown so much light on the subject of benzene itself and its more immediate derivatives, would prove an equally trustworthy guide in the case of the more complex hydrocarbons of the same class. But it is doing no injustice to pure chemists to say that a great part of this expansion is attributable to the fact that numerous valuable practical applications have been found for some of the compounds in question.

In 1876, when Wurtz published his "Progrès de l'Industrie des Matières Colorantes Artificielles," the colouring-matters derived from naphthalene might be counted on the fingers of one hand, and not more than two of these—Magdala red and Manchester yellow—were really manufactured; whilst from diphenyl not a single dye-stuff had been prepared. At the present moment, only a specialist in this branch could estimate, even approximately, the number of the naphthalene dyes; and within the last few years another important class of dyes, possessing the hitherto unknown property of dyeing cotton without a mordant, has been discovered among the derivatives of diphenyl.

The industrial source of much of our knowledge in this branch of chemistry is clearly shown in the fact that in the work now before us the references are not confined to the familiar scientific periodicals, but extend to the patent literature of various countries and to works like Schultz's "Steinkohlentheer" and Friedländer's "Theerfarben." Without going into unnecessary detail, the authors succeed in giving all which it is necessary for the student of organic chemistry to know regarding these matters.

The questions of constitution are treated very fully and clearly. The reader who wishes to gain an idea of what organic chemists have accomplished, in the solution of problems which but a few years ago would have been regarded as utterly beyond the scope of rational investigation, cannot do better than study carefully the chapter on the constitution of the naphthalene derivatives.

The authors continue to follow their excellent practice of giving interesting historical details by way of introduction to the study of the more important compounds.

The Oak: a Popular Introduction to Forest Botany. By H. Marshall Ward, M.A., F.R.S., F.L.S. "Modern Science Series," edited by Sir John Lubbock, Bart., M.P. 171 pages, and Index, 2 Plates, and 51 Woodcuts. (London: Kegan Paul, Trench, Trübner, and Co., Ltd., 1892.)

THIS little book fills a distinct gap, as it is the first time that a primer intended specially for students of forestry has been issued in England. Prof. Marshall Ward has been for many years the Lecturer on Botany at the Royal Indian Engineering College at Cooper's Hill, and therefore understands thoroughly what is required. He has followed for his plan the taking of a single tree—the oak—and dealing with it exhaustively. After a general introduction, he deals first with the acorn and its germination, describing fully the embryo and its epidermis, the vascular bundles of the former and its cells, and the character of their contents. He tells us that two years elapse before the supply of food stored up in the two thick cotyledons is exhausted, and it is not until the tree is from sixty to a hundred years old that good seeds are obtained from it. Then he describes the seedling and young plant—first the root and its tissues, and then the stem, buds, and leaves, and their microscopic structure. Then he turns to the full-grown tree, and describes its root-system, shoot-system, inflorescence, flowers, fruit, and seed. Next he deals with the timber of the oak, its structure, and technological peculiarities. Then he treats of the cultivation of the tree, and the injuries and diseases to which it is liable from the attacks of insects and fungi. He concludes with a short chapter on the relationships of the oaks and their distribution in space and time. The genus is characterized by the cupule, in which the acorn is inclosed, which represents a one-flowered involucre. There are three cells in the ovary, and two ovules in each; but nearly always two of the cells and five of the ovules are obliterated before the seed is perfected. About 300 species of the genus *Quercus* are known. It is spread universally through the north temperate zone. Prof. M. Ward is mistaken in supposing there are no oaks in South America. Two species have long been known in the Northern Andes—*Quercus tolimensis* and *Quercus Humboldtii*—both of which are described and figured in Humboldt and Bonpland's "Plantes Equinoxiales." There are nearly sixty species in India, and it is there that we get the genus connected with the other Cupuliferæ by passing through *Castanopsis* into *Castanea*. The oaks go back to the Cretaceous period, and a large number of fossil forms are known. Their delimitation into species is very difficult. In Britain we have only a single species, *Quercus Robur*, with two sub-species *Q. pedunculata* and *sessiliflora*, well enough marked in their extreme forms, but passing into one another by gradual stages of transition, which constitute what has been called *Quercus intermedia*. The book is clear and well arranged, and will be found thoroughly adapted to fulfil its purpose, and is illustrated by a large number of excellent figures, some of which are original and some borrowed from German text-books.

J. G. B.

The Elements of Plane Trigonometry. By R. Levett and C. Davison. (London: Macmillan, 1892.)

THOUGH the spirit of De Morgan's writings pervades these "Elements," there is ample evidence that the writers have taken an immense amount of pains in bringing them fully up to date. We have long given up looking for originality in a treatise on trigonometry; indeed, in a text-book for use in schools such a feature is hardly desirable, but there are not wanting here many novel features in the matter introduced and in its mode of treatment. De Morgan's influence is shown "in the use of the negative hypotenuse in defining the ratios, in the more definite meaning assigned to the notation for inverse functions, the manner in which the addition formulæ are extended to any number of variables, the geometrical treatment of the hyperbolic function and of complex numbers, and in the two-fold generalization of a logarithm to a given base." Another work to which the authors are indebted in Parts II. and III. is Prof. Chrystal's masterly treatise on algebra. In fact, they are *au courant* with whatever has recently been written bearing in any way upon their subject-matter.

The book is divided, like ancient Gaul, into three parts. The first treats of arithmetical quantity, in five

chapters; the second of real algebraical quantity; and the third of complex numbers. The first two parts contain what is requisite for school use, the third is beyond the ordinary run of junior students. The whole has, we believe, stood the test of class work. In the second part the application of trigonometry to surveying is made interesting by treating the subject as practically as possible. There is a copy from a photograph of a theodolite, and a conversational description of the same, and in Part I., through the permission of the publishers, there is printed a portion of the map of the *Mer de Glace* given in the "Life of Prof. Forbes." These little points are likely to interest young students. Of course the hyperbolic functions are discussed, but they are discussed in a way that is novel to us in some of the details; for instance, geometrical proofs are given of cosh $(u+v)$ and sinh $(u+v)$. These strike us as being very elegant and quite within school range, as they need only a moderate acquaintance with the properties of the rectangular hyperbola. A short space is occupied with the Gudermannian function, and a table of approximate values of hyperbolic functions is given in the same section. The section on convergency and continuity of series, and, in fact, the whole discussion of series, is very carefully done.

Our summing up is that the book is one of the best we have met with on the subject, and quite fitted to hold its own against the two or three formidable rivals that have lately appeared in the field. There is a plethora of carefully chosen examples, which we advise the junior student to use with Prof. Chrystal's caution in mind: "I should much deprecate the idea that any one pupil is to work all the exercises (in the 'Algebra') at the first or at any reading. We do too much of that kind of work in this country." The text is further illustrated by many *graphs* of different functions, and answers, carefully tested from working with pupils, are appended at the end, with tables of the logarithms required for the exercises.

Les Fleurs à Paris: Culture et Commerce. Par Philippe L. de Vilmorin. (Paris: J. B. Baillière et Fils, 1892.)

THE trade in cut flowers is now quite an important department of commerce, and it is rather surprising that a good many attempts have not been made to give a full and connected account of it. In the present volume M. de Vilmorin deals with the subject chiefly in its relation to Paris, and he has brought together many facts which will be of interest both to lovers of flowers and to students of social economy. He describes the various ways in which the trade is organized in the French capital, the sources from which the flowers are derived, the manner in which they are cultivated, and the means by which they are distributed. He then presents an account of the various kinds of flowers used for decorative purposes, giving in simple language such botanical details as are likely to be intelligible and attractive even to non-scientific readers. The volume is abundantly and very prettily illustrated.

Health Springs of Germany and Austria. By F. O. Buckland, M.D. Second Edition. (London: W. H. Allen and Co., 1892.)

THIS little book ought to be of considerable service to invalids who may desire to obtain aid in the choice of a Continental health resort. The author does not profess to present elaborate details as to the various springs with which he deals; but he says enough about each to give a sufficiently clear idea of its merits and defects. He offers also some good general remarks on the nature and uses of health springs. In the present edition he has made little change, but he has increased the value of the book by adding an index.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Heat Engines and Saline Solutions.

I HAVE nothing to modify in what I have written under the above heading (p. 438); but to deal completely with all the questions raised by Mr. Macfarlane Gray (p. 486) would require half a treatise. I will limit myself to a few brief remarks.

(1) In Carnot's engine there is no (separate) boiler or condenser.

(2) When I spoke of the various parts of the working substance being in equilibrium with one another, I referred to complete equilibrium, thermal as well as mechanical. If the temperature varies from one part to another there is no equilibrium.

(3) On the above understanding the pressure of vapour in equilibrium with a saline solution of given strength is a definite function of the temperature.

(4) Let me suggest that the origin of the difficulty may lie in the phrase "superheated vapour," which has not so definite a meaning as Mr. Gray seems to ascribe to it. Whether vapour be superheated or no, depends, not only upon the condition of the vapour itself, *but also upon the bodies with which it is in contact.* Vapour which is merely saturated in contact with a saline solution must be regarded as superheated when contact with the solution is cut off. In the first situation it would condense upon compression, and in the second situation it would not.

In conclusion, I will hazard the prediction that, if the heat engines of the distant future are at all analogous to our present steam engines, either the water (as the substance first heated) will be replaced by a fluid of less inherent volatility, or else the volatility of the water will be restrained by the addition to it of some body held in solution.

RAYLEIGH.

On Earth Vibrations.

IT seems that the earth, once set in vibration, maintains this state for a long time before coming to rest. The observers of Greenwich (see Major H. S. Palmer in the Transactions of the Seismological Society of Japan, vol. iii., p. 148) found that from time to time, at considerable intervals, there was an evening when the usual observations for determining the collimation-error of the transit-circle by means of reflection in a tray of mercury could not be taken, on account of the constant trembling of the surface of the mercury, which on such occasions continued until long past midnight. These are occasions when crowds of the poorer classes of London flock for amusement to Greenwich Park. A favourite pastime with the young people, often prolonged until after nightfall, is to clamber to the top of the steep slopes of the hill on which the Observatory stands—in fact, to the paling of the enclosure—and then, joining hands in twos or threes, to bolt precipitately to the bottom, where, as may be imagined, they usually arrive "all in a heap." Hundreds join in this sport on fine evenings, and the result, as shown by the behaviour of the mercury, is to set the whole of Flamsteed Hill in a tremor, which does not subside until early next morning, many hours after the people have left.

Another very beautiful proof of this fact offered itself to me in the Geophysical Observatory of Rocca di Papa, Rome. A slight earthquake coming from Aquila (at 110 kilometres north-east of Rocca di Papa) was felt and registered by the instruments at 9.39 a.m. mean time of Rome, on the 8th of last February. Just at that time I was casually observing through a microscope a pendulum 6 cm. long, which suddenly began to display great agitation.

Now such a pendulum, when removed from its equilibrium position for an amplitude equal to the observed, comes to rest in about half-an-hour. In the present case the pendulum continued to oscillate till the afternoon. Nor did the character of the vibrations correspond to the gradually and regularly diminishing oscillation of a pendulum which has received a single shock.

The pendulum is firmly fixed to a big column, deeply founded

in the basalt-lava, so as to give trustworthy indications of the real movements of the ground. Perturbing causes which would have kept the pendulum in agitation, such as wind, the passing of people, carriages, &c., had not on that day to be taken into account.

I think it rather improbable that secondary and subsequent shocks, coming from the same centre as the first one, were the cause of the observed fact: a much more probable explanation would be that the whole hill on which the Observatory is built maintained during the whole time the particular state of trembling produced by the first shock.

Rocca di Papa, Rome, March 18. EMIL ODDONE.

Striated Surface under the Cromer Drift.

AT the beginning of the present month (March) there were some good Forest Bed exposures in the neighbourhood of Cromer. Somewhat less than a quarter of a mile south-east of East Runton, there was an exposure I had not noticed before. It consisted of a smooth, hard surface of ferrugineous sand, not unlike some of our Trias beds, except that below it became softer. This slab of sandstone projected six yards obliquely from under the cliff, or rather talus in front of the cliff, with a slight dip to the west inwards, its outward face rising one foot above the sand of the foreshore. Upon the outer or longer exposed part there was no indication of striæ, but toward the inner or more recently exposed portion faint grooves could be distinguished, becoming more distinct the nearer it approached the cliff; two feet from the cliff they were distinct and numerous. The main direction of striæ ran due north and south, a few crossed from the north-north-west and north by east, but none deviated from the general direction beyond these points. They extended entirely across this part of the exposure, viz. 4 feet, and continued as far as the surface could be uncovered. Resting immediately above, as far as could be made out among the recent talus, was the highly-contorted drift sand and loam usually observed hereabouts; no flint nodules, stones, or boulders could be seen in them, and it is difficult to understand how these, if they had been present, could groove the bed so persistently in one direction when shoots took place.

About half a mile to the south-east and one mile to the north-west, the cliff sections this year show the soft sand and loam beds bent into anticlines, thrust back to a vertical position like a pack of cards on end, their central axes pointing to the north. This form indicates that the force came from the same direction as the mean striæ engraved upon the underlying surface. Three points of interest will be observed:—

(1) That the ice which caused the striations could hardly have contorted the beds above them; it probably shrank back and allowed the drift to be deposited, and then encroached once more and contorted the overlying beds.

(2) Soft beds of sand and loam could not be twisted or contorted into ribbon forms unless a considerable load lay above to prevent them breaking up and becoming disarranged.

(3) We should hardly expect to find striæ preserved upon a comparatively soft surface under what looks like bedded sand or loam; but unfortunately this point cannot be clearly established in consequence of talus obscuring the bed immediately above; but, bearing upon this point, it may be interesting to state during the summer of 1890 I found at Penrhyn, Nevin, Carnarvon Bay, a highly glaciated and striated rock surface which had been recently exposed. This *roche moutonnée* was overlain by a drift cliff of bedded sands and loams 100 feet high, resembling the Cromer drift in every respect except the contortions; these striations were from the east-north-east or seaward side also. WILLIAM SHERWOOD.

Sutton Coldfield.

Pilchards.

IN this far-off corner of the world the news has only just reached me that my name has been quoted in your valuable columns with Mr. Cunningham's article on the growth of the pilchard or sardine. As it is a matter which much interests me, I should like to have a word or two on the subject. Personally, I have no doubt as to the identity of the pilchard and sardine. Seeing the matter has been so well threshed out by our greatest ichthyologists—Couch, Day, and Günther—the spawning of the fish being only a question of local conditions, and not even giving us aid in determining the species—note the doings of the herring when about this work around the islands of Great Britain, which keeps shedding its roe for eleven months out of the twelve in these waters. As to the question of the English pilchard being so much larger than those of other countries, this to my mind is a subject of *grave doubt*, and I fear Mr. Cunningham's informants have not looked up the matter thoroughly.

When I was a juror in the London International Exhibition in 1883, in the Spanish department we gave awards to exhibitors who had pilchards of the same size and cure as those of Cornwall. Again, the principal markets for our Cornish pilchards are those of Italy. But in this business we are not alone, for side by side with our fish are the Spanish pilchards, cured like our own; generally they are a little smaller than ours, answering to our summer fish.

But in this past season they are decidedly our rivals, and in such quantities as to bring the price down in such a manner as to leave us with scarcely a margin of profit through their being just equal in size to our Cornish output.

In the past season we calculate that Cornwall and Devon have sent out about 25,000 casks of pilchards into Italy; but we should not be surprised to find that Spain has sent forwards into the same country over 30,000 casks.

We began the season by sending our fish forwards in September, and were rather surprised to find the Spanish merchants had glutted the Italian markets with fish in August, and the imports went on till near Christmas, which seems to indicate they were catching pilchards on the coasts of Spain in the summer and autumn of the year. When this question of the size of the pilchard has been fairly looked up, I think it will be found the size of the fish of any coasts will be chiefly governed by the facts that abrupt and exposed coasts, having a heavy sea and strong tides along them, will have the strongest and largest fish swimming in its waters; while the bays, and narrow and protected seas and inlets, will have the young, weak, and smaller fish in them, the nature of the foods having the lesser influence.

I have been led to believe the Bay of Douarnenez is the deepest bay on the coast of Brittany, and in it is carried on the largest fishery for young pilchards on the French coasts; while off the more abrupt parts of the coast of Spain the pilchards are large, like those on the exposed parts of Cornwall. And no doubt if the French coasts were well looked up, the same facts would come out respecting the fish there.

Fortunately for the French and Spanish fishermen, up to date they have not interfered with the food of the young pilchard; or, if they have, evidently they have substituted another in its room, viz. *cods' roe;* hence they have these little ones in their bays still; but we have driven out ours by starvation, as will be seen further on.

I was rather surprised to read Mr. Cunningham's statement when he said I had told him that I had never seen pilchards in Cornwall of the same size as the French sardines, for really I have seen millions just like them for size.

Possibly the error came from my misunderstanding his question, as we cannot see or get them now because of our altered conditions.

If Mr. Cunningham will consult F. Buckland's familiar history of British fishes (p. 109), he will see a letter from me confirming my statements, and written in the year 1872. In the year 1884 I received the medal of the Falmouth Polytechnic Society for exhibiting a series of small pilchards, showing their growth and ages in six stages—the smallest being less than an inch in length—up to the two years old full-grown pilchard.

Before the railway ran into our county, our bays were full of these little fishes in the summer months; and when our seines inclosed pilchards, the first question was their size, as pilchards under eight inches in length were useless for exporting purposes; consequently small fish were quickly turned back into the sea alive.

But sometimes, in the excitement and darkness of the night, the men were mistaken in the size of the fish, and took them into their boats; and when the daylight undeceived them the fish had to be carted off for manure. I have often seen them on our piers, piled up four feet high and hundreds of feet in length, waiting the waggons.

But all this has passed away, and we have not one pilchard seine left here to inclose pilchards should they again visit us. But their coming is very improbable, as the quantity of food necessary for their sustenance is so much diminished that if the

old numbers came on the coasts they would probably die in our waters for want of food. And this sustenance was evidently one of the greatest delicacy. Full-grown pilchards have been known to feed up to yielding from three to seven gallons of oil to the hogshead of 3000 fish when having their fill of it. Their food was young Crustacea,, and evidently was the larval forms of some crab or crabs which live on our coasts.

I think a few words will make this plain; in considering the great crab—*Cancer pagurus*—in the sea, the sexes stand in relation to each other of about one male to eight or ten females, the latter spawning from one to two million eggs. These, when hatched out, pass through several distinct larval changes in the surface of the sea before dropping down on the sea bottom.

Creatures having such vast procreative powers, when all the conditions of life are favourable, must produce more young than are wanted to make up for the wear and tear of the race; hence in our first outlook we seem in danger of having a plethora of crabs. But Nature, true to herself, has a police force at hand to prevent overcrowding. This is found in the pilchard, who attacks the crabs in the surface of the sea when in their zoe forms; while at the sea bottom, if they are yet too plentiful, those powerful skates (*Raia batis* and *Raia lintea*), with their long, sharp, hard noses, make their appearance among them, routing them out of their hiding-places among the rocks, and with their powerful jaws and teeth making short work with these crabs.

Hence, in the olden times, when there was no demand for the female crab, even at sixpence per dozen, and when they lay off our coasts in millions, and again throwing off their countless millions of eggs, there was seldom any lack of either large or small pilchards in our bays in the summer months of the year.

But since the extension of the railway systems throughout our land, and the demand came for all the crabs, not only have the large pilchards been scarcer, but they have so fallen off in condition as not to yield above one gallon and a half of oil to the hogshead, and the French sardine-sized fish has disappeared altogether.

It is certainly very satisfactory at this date to know that Mr. Cunningham has found them in their new haunts further out at sea; and that he has also verified the facts of the size and the ages of the pilchards given in my exhibits at the Falmouth Polytechnic so long ago. MATTHIAS DUNN.

Mevagissey, Cornwall, March 22.

On the Boltzmann-Maxwell Law of Partition of Kinetic Energy.

IN the very valuable Report on Thermodynamics drawn up for Section A of the British Association by Messrs. Bryan and Larmor, and now recently published, there is a remark upon the Boltzmann-Maxwell law of partition of Kinetic Energy, upon which I should like to be allowed to make a few comments. The Report says, in fact, after noticing the attempts to extend the theorem from the case, originally contemplated by Boltzmann, of molecules composed of discrete atoms under mutual forces, to the general case of dynamical systems determined by generalized co-ordinates: *It has now been proved beyond doubt that the theorem is not valid in this general form;* and quotes as a test case a paper by Prof. Burnside to the Royal Society of Edinburgh, on the collisions of elastic spheres, in which the centre of mass is at a small distance, c, from the centre of figure. In this paper, doubtless, results are arrived at, after a vigorous and able treatment, inconsistent with the law now under consideration; but there is, I think, an oversight, pointed out by Mr. Burbury in a paper recently read to the Royal Society of London, which vitiates these conclusions and leaves the matter where it was before.

Prof. Burnside, in fact, has omitted to introduce the frequency factor of collisions in proceeding to take his average, so that, whether his result be correct or not, for the average of all *possible* collisions, it is not correct for the average of all collisions *per unit of time*, and it is this last which is important for the test of permanence of distribution.

When this frequency-factor is introduced and the approximation carried, as in Prof. Burnside's paper, to the second power of c, it will be found, I believe, that $\frac{A}{k_1} = \frac{1}{h}$ and not $\frac{2}{h}$, so that if this statement is correct, we are hereby furnished with a confirmation of the Boltzmann-Maxwell law by an independent treatment.

The process is somewhat intricate, and too long for insertion here.

I should like to make a few additional remarks on a view expressed by Prof. Burnside, which is doubtless widely, but I think not quite reasonably, shared by many eminent mathematicians, to whom this theorem of partition of Kinetic Energy is a stumbling-block.

He says, in the paper referred to, "The method of proof adopted by Watson, following Boltzmann, is so vague as to defy criticism or attempts at verification," but I really think the vagueness consists in the generality of the conclusion and not in the method of proof. To establish a proposition applicable to all conceivable cases of collision, either in a field of no force, or of forces of any kind, requires a method of proof which, whether true or false, must of necessity be as general, or, if you please, as vague, as the conclusion; but, in point of fact, Boltzmann's method adapts itself readily to every case which, like this of Prof. Burnside's, admits of practical treatment. For example, in this very case of the colliding spheres with centre of mass distance (c) from that of figure, Boltzmann's method would assume that the number of spheres with lines of centres in any direction, and with component velocities of translation of C.G. and of angular velocities round the principal axes lying between u, $u + du$, &c., &c., ω_3, $\omega_3 + d\omega_3$, was

$$\phi(u, v, w, \omega_1, \omega_2, \omega_3)\, du \; . \; . \; . \; d\omega_3.$$

Suppose, then, the circumstances of the two spheres to be distinguished, as in Prof. Burnside's notation, by the great and small letters, U, u, &c., Ω, ω, &c., and let the corresponding dashed letters denote these respective quantities after collision.

Then, as proved in Prof. Burnside's paper, we have—

$$U' = \frac{2u + c^2(K+k)U - 2c\varpi}{2 + c^2(K+k)}, \quad u' = \frac{2U + c^2(K+k)u + 2c\varpi}{2 + c^2(K+k)};$$

$$\Omega'_1 = \Omega_1 + \frac{2cP}{A} \cdot \frac{U - u + c\varpi}{2 + c^2(K+k)}, \quad \omega'_1 = \omega_1 + \frac{2cp}{A} \cdot \frac{U - u - c\varpi}{2 + c^2(K+k)};$$

$$\Omega'_2 = \Omega_2 + \frac{2cQ}{B} \cdot \frac{U - u + c\varpi}{2 + c^2(K+k)}, \quad \omega'_2 = \omega_2 + \frac{2cq}{B} \cdot \frac{U - u - c\varpi}{2 + c^2(K+k)};$$

$$\Omega'_3 = \Omega_3 + \frac{2cR}{C} \cdot \frac{U - u + c\varpi}{2 + c^2(K+k)}, \quad \omega'_3 = \omega_3 + \frac{2cr}{C} \cdot \frac{U - u - c\varpi}{2 + c^2(K+k)};$$

where A, B, C are principal moments of inertia through C.G.; P, Q, R, p, q, r are quantities depending on the relative situations of the principal axes, the line joining the centres of figure and mass, and the line of centres at collision, and not affected by that collision.

$$\varpi = P\Omega_1 + Q\Omega_2 + R\Omega_3 + p\omega_1 + q\omega_2 + r\omega_3,$$

$$K = \frac{P^2}{A} + \frac{Q^2}{B} + \frac{R^2}{C}, \quad k = \frac{p^2}{A} + \frac{q^2}{B} + \frac{r^2}{C},$$

and the velocity of approach therefore equals $U - u + c\varpi$.

The Boltzmann method, therefore, would require, for the permanent or special state, the condition that

$$\phi(u \; . \; . \; \omega_3)\phi(U \; . \; . \; . \; \Omega_3)\, du \; . \; . \; . \; d\Omega_3\, (U - u + c\varpi)$$

should be equal to

$$\phi(u' \; . \; . \; . \; \omega'_3)\phi(U' \; . \; . \; . \; \Omega'_3)\, du' \; . \; . \; . \; d\Omega'_3\, (U' - u' + c\varpi'),$$

because, when this condition is satisfied, and only then, can the average number of spheres with velocity components in the undashed state and line of centres parallel to the x axis (which may be any direction), be equal before and after collision, inasmuch as those in the dashed state with velocities reversed enter into the undashed state.

In determining the multiple differential $du' \; . \; . \; . \; d\Omega'_3$, we may neglect the consideration of the resolved velocities in the tangent plane, v, w, V, W, inasmuch as they are unaltered at impact, and we have to evaluate the quantity—

$$\frac{1}{\{2 + c^2(K+k)\}^8} \cdot \begin{vmatrix} c^2(K+k), & 2, & 2cP, & 2cQ, & 2cR, & 2cp, & 2cq, & 2cr \\ 2 & c^2(K+k), & -2cP, & -2cQ, & -2cR, & -2cp, & -2cq, & -2cr \\ \frac{2cP}{A}, & -\frac{2cP}{A}, & 2 + c^2(K+k) + \frac{2c^2P^2}{A}, & -\frac{2c^2PQ}{A}, & -\frac{2c^2PR}{A}, & -\frac{2c^2Pp}{A}, & -\frac{2c^2Pq}{A}, & -\frac{2c^2Pr}{A}, \end{vmatrix}$$

and so on for eight lines.

It will be found that the determinant is equal to

$$-(2 + c^2(k + K))^8.$$

Also

$$U - u + c\varpi = -(U' - u' + c\varpi'),$$

whence the condition of permanence becomes

$$\phi(u \ldots \omega_3)\phi(U \ldots \Omega_3) = \phi(u' \ldots \omega'_3) - \phi(U' \ldots \Omega'_3);$$

a condition which is satisfied when

$$\phi = m(u^2 + v^2 + w^2) + A\omega_1^2 + B\omega_2^2 + C\omega_3^2.$$

A simpler case of verification, involving exactly the same principles, is obtained by replacing the spheres by circular disks confined to one plane. Here there will be only 6 co-ordinate velocities, u, v, ω, U, V, Ω, and the notation may be preserved as before, only

$$\varpi = P\Omega + p\omega, \quad K = \frac{P^2}{A}, \quad k = \frac{p^2}{A};$$

and neglecting v and V, the velocities resolved in the tangent, as before, we have, now, the factor multiplying the determinant reduced to $\frac{1}{\{2 + c^2(K + k)\}^4}$, and the determinant to 4 rows and columns instead of 8, which will readily reduce to

$$-(2 + c^2(K + k))^4.$$

There is, therefore, really nothing *vague* in Boltzmann's treatment: all that it does is to show on general dynamical principles that the functional determinant must be unity in all cases, and therefore avoid the labour of evaluation.

What has been thus done for the collisions of heterogeneous spheres and circles may be equally well done by the application of the Boltzmann method to colliding systems of any number of degrees of freedom; it will be found that there is no vagueness in the process, although, of course, the analytical difficulty may be greatly increased with the circumstances of different cases. And what I understand to be the meaning of the Boltzmann-Maxwell law of partition of energy will, I believe, be found to be true in each case. I understand that law to assert that when the kinetic energy of each system has been expressed, as it always can be, as the sum of n squares, as $P_1^2, P_2^2, \ldots P_n^2$, each of the P's being a linear function of the n generalized velocity components, the average value of each of these squares is the same in the special or equilibrium state. For example, where the system is a single rigid body with 6 degrees of freedom and twice the kinetic energy is

$$M(u^2 + v^2 + w^2) + A\omega_1^2 + B\omega_2^2 + C\omega_3^2,$$

the average kinetic energy in the special or equilibrium state contributed by each translation is $\frac{1}{6}$ of the whole, and the average kinetic energy contributed by each rotation component is the same. It does not appear to me that the law asserts more than this, or that any application that has been sought to be [illegible] of it requires anything more than this.

[illegible] conclusions are confirmed by Mr. Burbury in the paper to the Royal Society already mentioned, and by an entirely independent treatment.

I have purposely limited myself to the consideration of colliding elastic systems treated by the conventional laws of impact, because one such case had been specially singled out in the British Association Report, and I believe that in all such cases the Boltzmann-Maxwell law of partition will be found to hold good. The most general cases contemplated by Boltzmann and Maxwell, involving the considerations of forces between parts of the molecules themselves, with continued interchange of Kinetic and Potential Energies, as well as intermolecular and external forces, demand further space than could reasonably be asked of you.

H. W. WATSON.

Berkeswell Rectory, Coventry, March 21.

The Functions of Universities.

As it is most desirable that students of all classes should, as far as possible, be in contact with one another during the impressionable years of training, it is eminently desirable that schools of engineering should be connected with Universities. It is distinctly contrary to public policy that the present denominational education of students of different professions in special seminaries, whether they are ecclesiastical, or medical, or engineering, should be encouraged. The existing separation of professional and commercial education is most mischievous, and is very largely due to compulsory Greek. Anent this, all that I said was that the danger of a Pagan revival was the *best* argument for compulsory Greek; I did not say it was a *good* argument. About going to Colleges and Universities, I did *not* say that the student should go to a College and *not* to a University, if he ever had time and ability to benefit by University training. Very few can do this, hardly any undergraduates ever do; and what I deprecate is that University Professors should be expected to waste their time in making cripples run—that is what College teachers and private coaches are paid for doing. Some Universities, as, for example, that of Dublin, are too poor to pay double sets of teachers, but that is their misfortune, and should not be a precedent for a rich country like England, nor for the wealthiest city in the world, like London.

As to Prof. Ayrton's forgetting the debt due to those who studied useless subjects, I chode him for it because he sneered at useless subjects. If he still sneered at useless subjects, I would chide him still, even though he whited his prophets' sepulchres by using the whole scientific hierarchy to name his units after. As to my forgetting the debt due to the practical applications, my letter was too short to include everything in it.

Anyway, I entirely agree with Prof. Ayrton that the business of technical schools is to teach *useful* knowledge, and further, that the enormous majority of mankind are most fortunately employed in doing useful things, and should not be asked to waste their time on trying to do useless ones.

GEO. FRAS. FITZGERALD.

A New Comet.

IN last week's NATURE (p. 484) I announced the discovery of a new comet on March 18, and an editorial note was appended to my letter as follows: "This is stated to be Winnecke's comet." Will you kindly allow me to point out that this statement is based on a misconception, for the two comets alluded to are situated in widely different regions of the sky, and cannot possibly be identical, as a comparison of the following positions will show:—

March 18, 1892.

	R. A.	Decl.
Winnecke's Comet	191° ...	+ 31°
Denning's Comet	341 ...	+ 59

Bristol, March 26.

W. F. DENNING.

P.S.—The following is an ephemeris of the latter comet computed by Dr. Birdschof for Berlin midnight:—

	R.A. h. m. s.	Decl. ° '	Light.
March 29	23 49 2 ...	+ 60 32 ...	1·01
April 2	0 13 50 ...	+ 60 39 ...	1·00
6	0 38 8 ...	+ 60 34 ...	1·00
10	1 1 37 ...	+ 60 18 ...	1·00
14	1 24 4 ...	+ 59 52 ...	1·00

The comet reaches its perihelion on May 12.

W. F. D.

ON INSECT COLOURS.

I.

THE Editor of NATURE has been so kind as to invite me to give in these columns a short summary of certain investigations that I have been for some time past engaged in, upon the behaviour of various insect colours when tested by chemical reagents. A full account of these experiments, of the methods of working, and of the reagents used, has been published in the *Entomologist*,[1] to which journal I must refer my readers for any details that they may desire. Here, space will allow me only to give in a condensed form the broad results. It is necessary to say, however, that the remarks in this article have reference only to the colours of the Lepidoptera; and, further, of the *imagines* only. The experiments have been made by immersing the wings for *one hour* in the following reagents: strong hydrochloric acid; 50 p.c. nitric acid; 45 p.c. sulphuric; strong acetic; strong ammonia; 25 p.c. potassic hydrate; and 10 p.c. sodic hydrate.

[1] April 1890 to September 1891.

First of all, I must draw attention to a very important distinction between colours and colours. It is, of course, clear that a colour may be due either to a pigment or to the physical structure of the coloured body; and it was therefore very necessary for me to find out, so far as possible, which of the colours I might have to deal with were physical, and which pigmental. With regard to some of these, it could tolerably safely be conjectured—merely from the appearance—that they were simple physical colours; in such cases, I mean, more especially, where there was a distinct *sheen* or glow in the colour; and I have been able to confirm various conjectures that had previously been made, both by others and myself, as to these physical colours. But in many other cases—indeed, in the majority—nothing but experiment could decide the question; and in some instances the decision has been as unexpected as disappointing to me. In order now to classify the results that I had obtained, and to introduce as much order and method as possible into my explanations of them, I have already ventured to propose[1] the following scheme of colours: (1) pigmental colours; (2) interference colours, which include a very large number of insect examples, besides, of course, the iridescent colours displayed by the wings of dragon-flies, May-flies, &c.; (3) *reflection* colours, other than the interference colours—these will be found to include all the white-winged species that I have examined; and (4) it seems necessary to have a class of simple *absorption* colours, in order to include all those cases of black in which no pigment can be found, but, apparently, all the light-rays are absorbed in a dense coating of scales.

The limits of space at my disposal compel me to pass over the colours black and white with the remark that as to the former, with one or two dubious exceptions, it can be affected by no reagents, and I have, therefore, concluded it to be not pigmental, but simply a "physical" absorption colour; full details as to this will be found in the *Entomologist*. As to white, I have similarly failed to find any pigment, or to obtain any reaction, except with *Melanargia galathea*, and two or three white-fringed species; in these instances the white is changed to a *deep yellow*, which presently dissolves in the reagent. The explanation of this I must defer until the phenomena of yellow have been discussed. For the rest, white is evidently simply a reflective colour, and not pigmental.

We now have to consider in succession the five colours blue, green, red (and pink), yellow (and orange), and chestnut; and, first of all, I must recur to what was said above on the criteria of physical and pigmental colours. Referring my readers to the condensed tables of results, given at the end of this article, I think—as the results of what I have been able to learn from my experiments—that the following rules may be laid down. There are certainly two ways in which a pigment colour may be affected, and either effect is conclusive evidence of the presence of a pigment. Firstly, the colour may be dissolved out; the liquid is left more or less deeply coloured, and the wing is *white*, or colourless.[2] This is the case (*vide* tables) with all the yellows and chestnuts that are sensitive at all to the reagents, and also with the pigment greens in most instances. It is very important to observe that this change from a yellow or chestnut wing to a white one does *not* imply any change from a yellow pigment to a white one—as might at first be supposed from merely glancing at the records in the tables: it is not so. The change is due simply to a solution of the pigment, which has originally been developed, *not from a white pigment*, but in a white, *i.e.* previously unpigmented, wing. It will be necessary to refer to this again later in discussing the behaviour of *A. galathea*. It is scarcely necessary to point out how important a bearing the interpretation of such results has upon our view of the nature of white.

To proceed: the second criterion for pigment colour (and this, it is needless to say, cannot concur with the former) is what I have denominated the "reversible" or "reversion" effect; and this I have found only in the case of red,[1] which, I may observe, is out and away the most satisfactory colour to experiment upon. In these cases, the effect of the reagents (but chiefly of the acids) is to convert the red colour into a fine yellow or orange, from which the original red can be completely recovered by appropriate means, as will be explained in due course: here, again, there is indubitably a pigment in evidence. In some cases, however, where there is neither solution nor any "reversion" effects, but yet a (sudden) change from the original colour, it is extremely perplexing to decide whether we have to do with a pigmental or with a physical colour. Instances of this will be found in the tables, among the greens (*e.g.* *Argynnis* and *Thecla*) and the blues (*e.g.* the *Lycænidæ*). In such cases I have not ventured to pronounce definitely in favour of either view, although it appears to me that the evidence is strongly in favour of such colours being simply physical.[2] I do not think that there is the least difficulty, theoretically, in supposing such reactions to take place with mere physical colours; since the wing-surface, when soaked—even by an indifferent or neutral fluid—might well be so affected, at least temporarily, as to alter its reaction in the light rays, *i.e.* to alter the resulting colour. In such cases, then, we have an element of doubt to contend with.

Then, as to undoubtedly physical colours, there are certain blues and greens which, when examined with the naked eye even, can be seen to be, not a continuous patch of colour, but a mass of—so to speak—distinct dots. Speaking now on the strength of my experience with such, I think I am justified in stating that these may safely be pronounced off-hand, without experiment, to be physical. When such colours are tested with the reagents, they may either be entirely unaffected, or the colour may disappear, but reappear (usually quickly) on drying. It may *primâ facie* be retorted, and not unreasonably, that these should be considered pigment colours showing the reversion effect; but—as will be seen after the reversion effect of red has been described—there is really no similarity at all; and there can scarcely be a doubt that these are merely physical colours.

Again, a brilliant metallic-looking colour may be changed to a different colour, or sometimes to a dead brown or blackish (*vide* tables: green), and this effect may be either temporary or permanent; and yet, from the general appearance of the colour before and after the experiment, one may feel thoroughly assured that it is only a physical colour.[3] And lastly, in such cases, a brilliant blue, *e.g.*, may be unaffected by most reagents (or only temporarily so), whilst such a reagent as nitric acid or potassic hydrate may permanently dull or destroy the colour. This is perfectly intelligible, since in such cases the powerful reagent has no doubt damaged the surface structure. I have thought it only right and fair thus to outline the data on which my conclusions concerning the nature of these colours have been founded,

1 *Entomologist*, September 1890.

2 The apparent exceptions of *Vanessa io* and *V. atalanta* will be explained under "chestnut," *infra*.

1 One or two instances have recently been noticed of partial reversion of a colour originally reddish-brown among the Bombyces. These seem to be connecting-links between yellow and chestnut descended colours (see later).

2 Facts in support of this view will be quoted in their proper place. But I may be allowed to say that one's judgment in such cases must be *partially* founded on observation of appearances and conditions that in their nature do not admit of being described or formulated, but appeal to an observer who has learnt by experience to interpret such indications. It will therefore be understood that, throughout this article, the actual evidence for my conclusions is apt to be somewhat discounted when the attempt is made to briefly convey it in words.

3 I ought to add that it is *not* always safe to assume, merely because the reagent has become coloured, that the surface colour under examination is a pigment colour; for some recent observations have led me to believe that there may be an unapparent pigment present in wings whose surface is physically coloured only.

although feeling that it is very difficult indeed to convey, merely by a brief verbal definition, the practical distinctions that one has slowly learnt from experience to recognize. We will now take each of the colours in detail, although, after this general account of the behaviour of physical colours, there is not much left to say of blue, or even of green.

If now the tables of results be referred to, it will be seen that I have arranged the blues in five different groups; but the differences between the first three—or probably four—are so slight that they might almost as well be thrown together. It is, however, somewhat convenient to consider them apart. In the first group the blue is a magnificent velvet blue, with a rich glow. *Primâ facie*, it is evidently a physical colour (as Wallace, *e.g.*, had pointed out years ago), and its behaviour when tested with reagents leaves no doubt of this. Reagents either are without effect, or cause a temporary dulling which disappears on drying, or plainly and permanently injure the wing, and destroy the beautiful glow or even the colour entirely. In cases of merely temporary dulling, where the full colour returns on drying, I believe that the effect is due simply to the soaking of the wing, and that neutral liquids would produce the same effect. The second group, after the explanations I have already given and the information that I have tabulated, requires very little comment. The various reactions abundantly showed that all these are simply physical (interference) colours. The third group are hardly distinguishable from the second: the behaviour of the blue on *P. machaon* when wetted with a reagent and then dried, is an excellent example of such physical colours as were referred to above. Now, concerning the fourth group, which in all probability should be considered as one with the three foregoing. I presume that most people are familiar with our beautiful and common *Vanessa* butterflies, the "Peacock," "Admiral," and "Tortoiseshell," and know that the borders of the wing are marked in the two latter (as well as in the "Camberwell Beauty") with spots of blue, while in the "Peacock" there are magnificent blue ocelli. The position of many of these marks strongly reminded me of the special positions of blue in various flowers;[1] and at the commencement of my experiments I was in great hopes of discovering a blue pigment in these *Vanessæ*; but after repeated experiments I was driven to conclude it almost certain that the blue here is simply physical. Its reactions throughout indicate as much; since, on being treated with the reagents, it either is wholly unaffected; or it disappears, but returns on drying; or it pales to a sort of grey that resembles the effect produced in the species of the third group; or lastly, it may in some cases disappear entirely, as I have already pointed out that some physical colours may. Finally, we have in the fifth group, containing the little blue butterflies of the family *Lycænidæ*, the only instance I have found of a blue not certainly physical, and even here the evidence is, I think, in favour of a physical colour. The question, however, is an unusually perplexing one; and for a long time I supposed that these were pigment blues, but I am very doubtful about them now. There is no solution, and I have no evidence of any reversion effect; the colour is changed certainly, and it is rather significant that in several of the deeper coloured species the artificial colour thus obtained is nearly identical with the normal colour of *P. corydon*; but such changes in no way preclude the colour being physical. The fact, too, that in several instances the effect was to produce a green or greenish tint now appears to me very suspiciously indicative of a physical colour (cf. *Papilio polyctor* in group 2). I may add, too, that the reaction of the green in the closely related "Hairstreak" butterfly, *Thecla rubi*, which I think is in all probability physical, must also be taken into account; for the reaction in that instance is similar in general character to that of these blues.

[1] *Vide*, or instance, Grant Allen's "Colours of Flowers."

To sum up, then, the case for this last group of blues, it seems to me that we cannot certainly conclude them to be physical, but the evidence points very stongly to the view that they are—like the other blues—physical and not pigmental. Should this conclusion be correct, I have as yet found no instance of pigmental blue among these Lepidoptera.

We will now pass on to green. It will be seen that in the tables I have divided green into three groups; of these, the first are unmistakable physical colours, exactly analogous to the group of metallic blues, and it is therefore unnecessary to comment further on them. The second group, though not metallic, are nevertheless, I believe, also simple physical colours. Not only can I say of them what was said of the blue *Lycænidæ*—that there is not the slightest evidence for any pigment; but I may go further, and say that there is some evidence for the green being physical. The striking characteristic of this group is that every reagent *instantly* turns the green to a brown or bronze brown,[1] which reaction might, as far as it goes, equally betoken either a pigment colour of the "reversible" nature, or a mere physical colour. That it is of the latter nature is indicated both by the fact that I have observed, no true reversion effect (always defining this reversion effect by the standard example of red), and also since it is possible to produce a similar, though only temporary, transformation by pure water or by alcohol. This, I think, makes very strongly indeed for the colour being simply physical, loth as I am to recognize that the magnificent and interesting greens of such species as the *Argynnis fritillaries*, and *Thecla rubi* are unpigmental. Still, my final conclusion, after prolonged and careful consideration, is that these colours are simply physical.[2]

Coming now to the third group of greens, we have here undoubtedly pigment colours, showing the solution effect. There are various degrees of solubility among them, and a varying sensitiveness to different reagents; but the summary, in brief, is that the green pigment is dissolved out, leaving a white, *i.e.* unpigmented, wing. Here, again, I need merely repeat what has already been said of yellow, and will again be referred to, viz. that the (green) pigment has been developed, *not from a white pigment*, but in a white, *i.e.* unpigmented, wing. A further question, however, arises—whether green has been directly evolved as such, or is a second stage in the coloric evolution. If the table be examined, it will be found that in several cases the green has been transformed to *yellow* or yellowish; and this has occurred too commonly to be otherwise than significant. I am therefore of opinion that green has been evolved from yellow, and that the production of yellow in these cases under the influence of the reagents is a retrogressive metamorphosis comparable with the production of yellow from red. The evidence admittedly is not anything like so conclusive or copious for the inference of this derivation of green, and I should, perhaps, hardly have advanced this view but for the analogy to the standard behaviour of red. As it is, however, it seems to me incumbent to hold—at least provisionally—that these pigment greens have been evolved from yellow.[3] It is, however, very evident—as will appear from the following discussion—that the respective relations of green and red to yellow are very different indeed, although there be a community of descent. It may be well to point out also that these greens occur in three very different groups of the Macro-Lepidoptera, viz. in the Rhopalocera, the Noctuæ, and the Geometræ. The apparent exception of *Cidaria* will be referred to later; it

[1] It is especially interesting that in *T. rubi* this brown is the same as the usual *ground* colour, constituting the greater part of the wing surface.

[2] A discussion in somewhat greater detail of this group—indeed, of the greens in general—will be found in the *Entomologist* for May 1891.

[3] Cp. also *Entomologist* for May 1891.

is just possible that in these species the green is descended from, not yellow, but chestnut.

Quitting the greens,[1] we now come to what is out and away the most satisfactory and interesting colour that I have studied—that is to say, red. Owing, however, to the very intimate relations of this colour to yellow, it is difficult to discuss them apart, and we will therefore take yellow and red together. Referring, now, first of all to the table of reds, what do we find as the general result? Omitting for the present (since they must be considered later) the last four species, we find that in practically every instance red is (rapidly or *instantly*) changed by acids [2] to some kind of yellow or orange; or, to state it in terms of the views that I have been led to adopt, red is retrogressively modified into the yellow from which it was originally evolved.[3] *Here, however, the change stops;* for, with the one striking and interesting exception of *Delias* (and perhaps one might add one or two of the pale pinks occurring among the Sphinges), the yellow thus produced is *immovable*. And since the species experimented upon include all varieties of red, and represent all the groups of Macro-Lepidoptera, one might apparently conclude that, although red is an exceedingly sensitive colour, yellow can never be affected. Yet, if the table of the *normally* yellow species be examined, it will be found that, in an immense number of these, the yellow is either partially or wholly dissolved by various reagents, leaving a pure white wing. Here, therefore, we find ourselves at once face to face with the problem of the character of the yellow pigment, and to a consideration of that we must turn before proceeding further with red.

It will be observed that in this table of yellows I have divided the species examined into four groups. Omitting for the present the small second group, we may distinguish three stages, represented by the three groups 1, 3, and 4.[4] This division has been adopted in order to illustrate what seems to me the most feasible explanation—at least for the present—of the constitution and behaviour of this yellow pigment. In the first group the yellow is exceedingly soluble, and a colourless white wing is the result. In the next stage (the third group) the yellow is more or less affected—sometimes very little moved, sometimes finely dissolved. In the last group the yellow is *wholly insoluble and entirely unaltered.* Also be it noted that in group 1 pale light yellows predominate, while in the last group the yellow is chiefly orange. It is, further, clear from this that a complete classification of all the yellows would include in this fourth group all the yellows artificially produced by reacting on the reds. Now, the explanation which I have adopted in order to cover all these facts is as follows. It appears that the yellow pigment, when first [5] evolved, is exceedingly sensitive and susceptible of evolution by various reagents; in this stage, too, it is probably of a comparatively pale or light yellow colour. In course of time the yellow pigment may in various instances become slightly altered in constitution (generally accompanied by a change to a deeper or more orange tint), and altered in the direction of *greater stability;* or rather, to confine ourselves to the literal facts, altered to the extent of becoming far less soluble. Of this intermediate stage we have examples in group 3. Finally, in group 4 we have examples of the last stage of evolution, when an—usually deep-coloured—insoluble yellow has been evolved. It appears to me, therefore, that *usually* red is evolved only after a long apprenticeship of yellow, and this is as much as to say that as a rule the yellow has become stable and insoluble before its evolution into red: this explains why red can be converted into yellow, but usually *no further.* On the other hand, the striking instances of *Delias* and one or two pink species show that occasionally the development of red has been so rapid that the yellow had not previously become stable.[1] The very parallel examples of *Cardaminus edusa* and *Lycæna phlœas* and *virgaurea* should be compared with these.

There is, however, still in my mind an open point as regards several of the yellow species in the last group; for it is not clear by any means that we may not have included here one or two *physical* yellows as well. We know that the yellows of the first three groups are entirely pigmental, for their solubility shows this; and we know that in the fourth group several species, such as *Deiopeia bella*, *C. hera lutescens*, *A. villica*, are pigmented, since their relations to red species which yield a similarly insoluble yellow proves this; but in the case of, for instance, *T. pronuba* (the "Yellow Underwing") and its miniature analogue *Heliaca*, we are totally in the dark; and it appears safer to me to withhold for the present any opinion as to whether these be physical or pigmental yellows. Were there any red underwing in the same genus as either of these, that would be sufficient to justify us, by analogy, in considering the yellow of these species pigmental, just as we do that of, *e.g.*, *Arctia villica;* but failing such evidence, the experimental evidence is not decisive in either direction.[2] There is, however, a most remarkable and exceptional set of phenomena connected with these yellows that I once thought might prove the criterion by which to distinguish between pigmental and possibly physical yellows in doubtful cases such as that of *T. pronuba.* Some time ago it was incidentally observed by Mr. Edwards that the wing of a species of *Colias* left in a damp cyanide bottle *was turned red.* This statement was brought under my notice by Mr. T. D. A. Cockerell, first of all in the columns of the *Entomologist*, and later in a private communication. I must frankly admit that for a long time I remained entirely incredulous of this alleged fact, since it was utterly opposed to all my own experience. I had observed nothing but *retrogressive* modifications of colour, whether by solution or simple change, and had found potassic cyanide (in solution) to rapidly dissolve the yellow of *Colias*, leaving a simple white wing: it was therefore very difficult to credit such a statement.

I will not trouble the readers of NATURE with any detailed account of my experiments [3] in this direction, made with the purpose of verifying—or otherwise—the correctness of Mr. Edwards's statement; but will simply say that I finally succeeded (owing really to a lucky accident) in verifying this. A yellow wing of *Colias* placed on *wet* cyanide is turned red, in spite of the solvent action of the cyanide: such an effect could never be attained by using a cyanide *solution*, because all the yellow would be dissolved out of the wing in a very short time; it is therefore necessary to hit the happy medium between dry cyanide and solution: as it is, a good deal of the yellow always goes into solution, but sufficient is left in the wing to be reddened. I have not stopped, however, at *Colias*, but have examined a number of other yellow species, with the result that I find many yellows become changed by this method to a really brilliant red

[1] I have not thought it worth while to refer here to the pseudo-green of *Euchloa cardaminus: vide Entomologist*, May 1891.

[2] It is unnecessary here to regard the less marked and less interesting alkaline reaction.

[3] Some remarks on this subject will be found in the *Entomologist*, xxiii. 370–71.

[4] It is, of course, to be understood that, like all rigid divisions, this is to some extent artificial. Evidently Nature knows nothing of three or four sharply-circumscribed groups of yellow, but merely an indefinite series, of which the first members would fall into my first group, and the last into my fourth, and so on.

[5] I speak, of course, in a phylogenetic sense.

[1] See a full discussion in the *Entomologist* for January last.

[2] It is, however, to be noted that in *one* case I found the yellow of *T. pronuba* very faded; but I do not care to contend for a pigment on the strength of this alone.

[3] An account of these will be found in the *Entomologist* for July 1891. I hope that I have made it sufficiently clear that I have no shadow of a claim to any credit in discovering this extraordinary phenomenon. Most certainly I should not have found it out in the course of my own experiments, or even afterwards but for Mr. Cockerell's insistence on the accuracy of his statement.

—which red seems indefinitely permanent if the wing be removed and dried. It will be seen that, in the table of yellows, several species are marked as showing the "cyanide effect"; whilst others are marked "no cyanide effect." The former are those in which I have succeeded in obtaining the reddening;[1] the latter will not redden. Now, since the former are all known to be pigmental yellows, whilst one of the latter, viz. *T. pronuba*, is the doubtful case, it seemed probable that this cyanide reaction might take place *always and only* with pigments, and thus afford the desired criterion. But in extending my experiments this hope proved fallacious, for I found—as is noted in the table—that various pigment yellows gave no reaction: the typical case on which I relied was *C. hera lutescens:* had this yellow, which is assuredly pigmental, although quite insoluble, been reddened, I should have felt justified in accepting the criterion. But not the slightest reaction took place with this species. I must not linger longer on this certainly fascinating subject: it is clearly one that requires thoroughly working out, and my investigations thereupon, are being carried on in several directions; but I may point out the great interest attaching to a reaction by which we can produce a coloric change practically identical (at least in its effects) with that which progressive evolution has produced in many species formerly yellow but now red.

Before, however, quitting yellow, there are one or two points yet that need explanation. In group 2 in the table, I have included two species showing a rich orange colour: this, though clearly marking a considerable progress in coloric evolution from the presumably primæval pale yellow, is yet *exceedingly soluble*: these instances, which, therefore, are very comparable with the red of *Delias*, are another proof that advance in depth and richness of colour is not necessarily always accompanied by decreasing solubility. I may add that I do not regard the orange of these two species as being in the direct line of evolution from yellow to red, but rather as a collateral or branch line also springing from yellow.[2] It is specially interesting that in this circumstance, as also in so many others, there is an exact parallel among the chestnuts.

And lastly, among the phenomena of yellow, we have to deal with the reaction of *Argia galathea*, already referred to; a reaction in which, contrary to all other experience, a white wing is changed to yellow by various reagents. It is very evident that, since I deny the existence of any pigment in white wings, and assert the yellow to have been developed in a previously unpigmented wing, and not by evolution from a white pigment, it is all-important for me to clear up this matter. My explanation, which has been given in some detail in the *Entomologist* (xxiii., pp. 341–43), is—to be as brief as possible—the following. It is, of course, well known that the pigments of both animals and plants are decomposition products of the protoplasm, whether produced directly by decomposition of the protoplasmic molecule, or indirectly by union of two or more decomposition products. Now, I take it that in this species—*A. galathea*—the metabolic processes have not yet produced any pigment, *but very nearly so;* that there exists in the wing a very unstable *mother-substance* (itself a decomposition product, whether produced immediately from the protoplasmic molecule, or indirectly from a molecule of intermediate complexity); and that the action of any powerful reagent is to decompose this, forming the yellow pigment; which pigment, as soon as formed, commences to dissolve in the reagent, as so many normal yellows do.[3]

[1] I have also obtained it with *Loxura atymnus*. It is very significant that I have in no case obtained it among the Heterocera (moths), but only among the Rhopalocera. Cp. *infra*, on chestnut.

[2] It is very interesting that the orange of *G. cleopatra* first of all is changed to the ground yellow, and then dissolved.

[3] I may point out that in the female of *A. galathea* there is already a cream tint in the wings.

This view, although at present necessarily somewhat hypothetical, appears to me to offer a satisfactory explanation of the apparently anomalous behaviour of *galathea*.

F. H. PERRY COSTE.

(*To be continued.*)

NOTES.

MR. ALFRED RUSSEL WALLACE AND MR. EDWARD WHYMPER are to receive the Royal Medals of the Royal Geographical Society at its annual meeting on May 23 next. The annual dinner of the Society will be held on the evening of that day after the annual meeting. The annual *conversazione* will take place about the middle of June in the South Kensington Museum.

MR. CHARLES HOSE, Resident on the Baram River, in the Rajahship of Sarawak, has recently explored that river to its sources, and ascended Mount Dulit, one of the summits of the main range which traverses this part of Borneo, to a height of 5000 feet. His zoological collections, which have been forwarded to the British Museum, contain many fine novelties. Among the mammals, which were described by Mr. Oldfield Thomas at the last meeting of the Zoological Society, are representatives of a new Carnivore of the genus *Hemigale*, two new Insectivores of the genus *Tupaia*, and a new Squirrel. The birds, which are being worked out by Dr. Bowdler Sharpe for *The Ibis*, likewise contain several remarkable new forms, amongst which is a new species of the restricted Eurylæmine genus *Calyptomena*, intermediate in size between *C. viridis* and the large *C. whiteheadi* of Mount Kina-balu. Mr. Hose is a nephew of Dr. G. F. Hose, the Bishop of Singapore and Labuan.

AMONG the names attached to the recent protest of members of the corporation and teaching staff of University College, London, against the Gresham Charter, we notice the following representatives of science and Fellows of the Royal Society:—Sir F. Abel, Prof. I. B. Balfour, Sir Henry Bessemer, H. S. Caxter, Sir J. N. Douglass, W. T. Thiselton-Dyer, Prof. W. H. Flower, Prof. E. Frankland, Dr. George Harley, R. B. Hayward, H. Hudleston, Prof. T. H. Huxley, Prof. E. Ray Lankester, Prof. Norman Lockyer, Prof. O. J. Lodge, Sir John Lubbock, Prof. D. Oliver, Prof. J. Prestwich, Prof. G. J. Romanes, Sir Henry Roscoe, Prof. Burdon Sanderson, J. Wilson Swan, Prof. Sylvester, E. B. Tylor, and Prof. W. F. R. Weldon. The protest contained equally influential names in the fields of literature, art, and politics; thus forming a document having no small weight in the final decision of the Government regarding this futile attempt to solve the problem of a Metropolitan University.

WE regret to have to record the death of Sir William Bowman, F.R.S., the eminent ophthalmic surgeon. He died of pneumonia at Joldwynds, his house near Dorking, on Tuesday last. He was born on July 20, 1816. In 1840 he was elected assistant surgeon at King's College Hospital, where he afterwards became full surgeon. He was also for a time assistant surgeon, and then full surgeon, at the Royal London Ophthalmic Hospital. He acted as the first president of the Ophthalmological Society of Great Britain, which he helped to found; and in 1884 he was created a baronet in recognition of his professional eminence. Sir William was a master of the various methods of ophthalmic surgery, and did much to improve them and to place them on a sound scientific basis. He held a leading place among those who made accessible to English students the knowledge obtained by the invention of the ophthalmoscope; and to him belongs the honour of having overcome the hostility

with which Von Graefe's operation of iridectomy for the cure of glaucoma was received by some authorities in this country. He also devoted much attention to the treatment of obstructions of the tear passages, and to improvements in the operation for cataract. His microscopic work, so early as 1840, was recognized as work of high value. He was elected a Fellow of the Royal Society in 1841, and received one of the Royal Medals in 1842. He was a member of many other scientific Societies both at home and abroad, and honorary degrees were conferred upon him by the Universities of Cambridge, Dublin, and Edinburgh.

DR. R. THORNE THORNE, F.R.S., will succeed Dr. George Buchanan, F.R.S., as medical adviser to the Local Government Board.

PROF. LODGE has, with the approval of the Senate, appointed to the demonstratorship in electrotechnics at University College, Liverpool, Mr. Francis Gibson Baily, late Scholar of St. John's College, Cambridge. Mr. Baily took first-class honours in the Natural Science Tripos, and is now in the employ of Messrs. Siemens Bros. and Co

THE *Revue Scientifique* notes that at Kieff there is a chemist who is nearly as old as the late M. Chevreul was at the time of his death. This is Prof. Ignace Vonberg, who was born at Vilna on January 17, 1791. He was one of the last Professors of Chemistry at the old University of his native place, and afterwards held, until 1866, a similar position at the University of Kieff. He is said to enjoy excellent health.

IT has been decided, according to Norwegian newspapers, that Dr. Nansen's North Pole Expedition shall start on January 1, 1893. He has selected as members of the Expedition a young officer in the Royal Norwegian Navy, Herr Sigurd Scott-Hansen, who will make the astronomical observations, an experienced Arctic navigator, Captain J. Ingebrigtsen, from Tromsö, and Herr Sverdrup, by whom Dr. Nansen was accompanied in his journey across Greenland.

EVERYONE who occasionally visits the Zoological Gardens was sorry to hear of the death of the giraffe. Since May 24, 1836, the Gardens have never until now been without one of these interesting animals. Dr. P. L. Sclater, writing to the *Times* on the subject, says that during the past fifty-five years there have been in the Gardens thirty giraffes, of which seventeen have been bred and reared there. A male born on April 22, 1846, lived in the Gardens nearly twenty-one years. These facts prove, as Dr. Sclater says, that this animal (one of the most extraordinary forms among recent mammals) is quite fitted for captivity, and is well worthy of the expense and trouble incurred in its keep. The closure of the Soudan by the Mahdists has prevented the importation of giraffes for some years, and for the only individual now in the market (an old female) a prohibitive price is asked. The Zoological Society hope that the need may be supplied by some of their friends and correspondents in Eastern or Southern Africa.

DR. B. W. RICHARDSON will deliver at the Royal Institution his Friday evening discourse on "The Physiology of Dreams" on April 29, in place of Dr. William Huggins, who will give his lecture on "The New Star in Auriga" on May 13.

PROF. W. G. OWENS writes to us from Bucknell University, Lewisburg, Pa., U.S., that on March 15, at 2 o'clock p.m., a series of halos and parhelia appeared and increased in brilliancy until 4 o'clock, after which they faded gradually till sunset. The circles, arcs, and spots around the sun were highly coloured, sometimes showing almost the entire spectrum.

THE Report of the Meteorological Council for the year ending March 31, 1891, has recently been issued. The following changes relating to organization were under consideration during the year: (1) the purchase of a new house near Cahirciveen, to which it is proposed to move the Observatory from the island of Valentia, the former place being more suitable for observations; (2) the registration of the Council as a corporate body, under section 23 of the Companies' Act, 1867; (3) examination of clerks, keeping as far as practicable to the system followed in the Civil Service. The practice followed by the Office with reference to observers at sea remains unchanged. The number of voyages for which logs have been returned during the year was 156; instruments have also been supplied to various islands in the Pacific, &c. In the weather forecasting branch, a comparison of the forecasts issued at 8.30 p.m. during the year with the weather actually experienced, shows that the total percentage of success was 82. The results were best, 88 per cent., for the south of England, and worst, 77 per cent., for the south of Ireland. The hay harvest forecasts were very successful; as much as 95 per cent. of success was attained in some parts. To add to the means of obtaining warnings of stormy weather at exposed fishery stations, the useful practice of lending trustworthy barometers, adopted by Admiral FitzRoy, has been continued; the number of stations now supplied is 180. The subject of cloud photography has continued to receive attention, and the system of observation and reduction has been improved, so that there is reason to expect that satisfactory determinations both of the heights and the velocities of the various clouds will be made. The Council have requested Mr. W. H. Dines to carry out a series of experiments at Oxshott for the purpose of comparing the action of various forms of anemometers, as well as experiments on the resistances of curved plates and vanes. The work is nearly finished, and the results will be published.

THE *Deutsches meteorologisches Jahrbuch*, Bavaria, 1891, Heft 3, contains twelve cloud pictures, reproduced from photographs supplied by Hildebrandsson, Riggenbach, and others. These photographs have been collected by Dr. Singer, of Munich, who submitted some of them to the International Meteorological Conference held there last autumn, where the importance of the artistic representation of clouds was discussed. The Cloud Atlas, published at Hamburg in 1890, was recognized by a large majority as the first satisfactory attempt to obtain uniformity in cloud nomenclature; but a Committee was framed to further consider the future production of pictures in a cheap form, according to the types approved by the Conference, and Dr. Singer was asked to join that Committee. The pictures now in question may be considered as his contribution to the subject. The forms are well defined; the names proposed differ materially from the classification by Luke Howard, hitherto generally in use, more attention being paid to the average heights of the various types. There are, however, still distinct variations of cloud frequently seen, which are not represented in Dr. Singer's collection, and his system of classification, notwithstanding its merits, has defects which must, sooner or later, be dealt with.

THE *Times* of March 24 printed the following communication from a correspondent:—Under the direction of the Austrian Government an interesting series of deep-sea explorations has been conducted recently in the eastern parts of the Mediterranean, by a scientific party on board the *Pola*. At one point, about 50 nautical miles south-west from Cape Matapan, the *Pola* found a depth of 4400 metres (2406 fathoms), followed within a few miles further east by a depth of 4080 metres (2236 fathoms), which are the greatest depths recorded in the Mediterranean. They have received from the Austrian Hydrographical Board the name of Pola Deep. The great depression of the Mediterranean must thus be shifted considerably east from its former central position on the maps. Another deep area was

explored between Candia and Alexandria—the depths attaining from 3310 metres (1810 fathoms) some twenty miles south-east of Grandes Bay, and from 2392 metres (1208 fathoms) to 2120 metres (1322 fathoms) within a short distance from Alexandria; the maximum depth sounded being 3068 metres (1678 fathoms) in 28° 39′ 30″ north latitude, and 33° 19′ 54″ east longitude. The highest temperature was found during the first part of the voyage, at depths of 1 to 50 metres, the highest being 80°·8 Fahrenheit at 1 metre; the lowest temperature, 52½°, was observed at the issue from the Adriatic Sea, at a depth of 760 metres. In explorations conducted some two years ago in the Central Mediterranean, it was observed that the density of the water and its saturation with salt increased with depth, and the same was noticed in the western part of this year's cruise. But in the Eastern Mediterranean the density of water varies but very little in the different strata, and it is higher on the whole than in the west. The transparency of the water is very great in the Eastern Mediterranean. Altogether the *Pola* made no fewer than 50 deep-sea soundings, 27 of which touched depths of more than 1000 metres.

AT a meeting of the Royal Geographical Society on Monday, a paper describing a recent journey to the head waters of the Ecayali, Central Peru, by Mr. Alexander Ross, was read by Sir Alfred Blunt. The journey was undertaken by desire of the Peruvian Corporation. Mr. Ross was accompanied by Mr. Arthur Sinclair, who, like himself, had spent many years planting in Ceylon; and, for research in economic botany, by Mr. P. D. G. Clark, assistant at the Royal Botanic Gardens, Peradeniya, near Kandy, Ceylon. Their travels lasted five months, and were confined to the central portions of the interior. Mr. Ross said that not much of the Sierra visited by them was suited to modern systems of tillage. But in the Montaña there were vast areas at suitable altitudes well adapted for settlement by European immigrants. In the lower parts of the Amazon basin, in a climate more or less unsuited to white labour, immense tracts awaited only the introduction of Chinese or the Indian coolie to turn what was now a magnificent forest wilderness into a rich and thriving province. The Central Railway would have been completed to Oroya in June next, and the Chanchamayo road would be opened soon thereafter. In continuation of these, and to connect them with the navigable waters of the Amazon, the survey of a railway line had already been ordered. The immense influence these would have upon the future of Peru and its progress would then become apparent. At present, to those who had not seen that country's varied and unlimited mineral resources, its grand forests, its rich soil and splendid rivers, a full realization of the future of Peru was impossible.

AT a meeting of the Royal Botanic Society on Saturday last, the Secretary, in calling attention to the various examples of azaleas in flower from the Society's Gardens shown at the meeting, remarked upon the many intermediate forms represented between the single and so-called double varieties. In some the stamens were only beginning to assume a flattened shape, the anthers still remaining at the top; in others, again, following the usual course of formation of double flowers—namely, by alteration of parts instead of adding to their number, the whole of the internal organs had become changed into petals, depriving the plant of all opportunity of reproducing itself by seed.

THERE is some difference of opinion in America on the question whether the method of execution by electricity ought to be maintained. The American journal *Electricity* maintains strongly that it should. The newspaper reports as to the electrical executions which have already taken place go to show, it contends, that death has been almost instantaneous in every case. While this has been disputed by a few witnesses, almost all have conceded that loss of consciousness has followed immediately on the application of the current. "The muscular action which has been noticed cannot for a moment," says *Electricity*, "be attributed to any consciousness on the part of the criminal. It is purely a reflex nervous action which can be reproduced by applying a current to the nerves of an animal which has been dead for some time; in fact, a most vigorous muscular action can be set up in a dead body in this way. That the victim, however, is alive, or that he suffers pain in any degree, is not for a moment to be considered."

THE new number of the *Economic Journal* contains, among other things, the Rev. Prof. W. Cunningham's inaugural lecture delivered at King's College, London. It is on the relativity of economic doctrine, and is conceived in a thoroughly scientific spirit. In the course of his argument, Prof. Cunningham urges that the results of economic investigation are relative in a way in which the results of physical investigation are not. The physicist announces principles which hold good, without substantial modification, for the whole period of human existence on the globe; whereas there are areas, and probably periods of human existence, to which the very simplest economic principles are hardly applicable, since there are tribes which seem to be destitute of ideas of exchange. The movement of the earth, the principle of gravitation, are entirely independent of human existence and unmodified by its changes. Economic principles, on the other hand, are statements about human nature in some of its aspects; and the alterations in the human race, their habits and practices, cannot be left out of account, more especially as the economic side of life occupies a very different importance at different stages of human progress. In consequence of this distinction between economical and physical investigation, results that may be used as the bases of practical applications cannot be as readily obtained in economics as in physics. The art of navigation follows very closely on the observations and principles expounded by the astronomer, but there is need of much correction and allowance before the principles of the economist can be applied by the statesman to steer his course in regard to the details of any great social measure.

PROF. G. H. WILLIAMS, in an interesting paper printed in the latest of the "Johns Hopkins University Circulars," speaks of the important part played in the growth of geological opinion by those regions which happen to be near great Universities. Such districts, as he says, were naturally earliest and most thoroughly studied, and have therefore become classical for all subsequent comparison. He especially mentions the mining districts of Freiburg and Clausthal, the volcanic regions of Edinburgh and Bonn, and the Tertiary basins of Paris and Vienna. These have become, once for all, the type-localities for the geological formations which surround them. Such masters as Werner, Hutton, von Dechen, Cuvier, and Suess, have worked there, erecting monuments to themselves in the regions which they have interpreted. Prof. Williams's practical conclusion is that Maryland, which, from a geological point of view, is full of interest, ought to be thoroughly investigated by geologists connected with the Johns Hopkins University.

THE Council of the Mason Science College, Birmingham, append to their report for the year ended February 23, 1892, some interesting extracts from a report by the Principal on the educational work of the College. From these we are glad to learn that the year, although marked by no new and striking developments of the College work, was throughout a year of continued prosperity, both in regard to the number of systematic students attending the College classes and the excellence of the work done, as testified by the honours won at various University examinations. There was a decrease in the number of students attending the departments of zoology, botany,

metallurgy, and engineering, but a large increase in connection with the departments of modern languages, geology, chemistry, physics, and physiology.

THE Rugby School Natural History Society has now been at work for twenty-five years, and its report for the year 1891 shows that it is still full of vigorous life. The geological section, which lapsed ten years ago, has made a fresh start, and the meteorological, the architectural, and the photographic sections are stated to be "in a flourishing condition." The editors have added to the report an index of all the papers and records which have been published by the Society from the beginning.

WITH regard to the influence of electricity on the growth of plants, a series of experiments made by Prof. Aloi on *Lactuca Scariola*, maize, wheat, tobacco, and beans, indicate that atmospheric electricity exercises a beneficial influence on vegetation; that the electricity of the soil has a similar influence on the germination of seeds; and that the less luxuriant vegetation of plants which grow in the neighbourhood of trees is in great part due to the diminution of temperature.

THE effects of earthquakes on vegetation have been investigated by Signor A. Goiran, in the case of the seismic disturbances which occurred last June throughout Northern Italy. He found in this instance the uniform result to be to induce a more rapid germination of seeds, and a more rapid growth of the young plants, giving rise to a more luxuriant vegetation in the pastures, arable lands, vineyards, and shrubberies, accompanied by an unusually deep green colour of the leaves. These results he believes to be due, not to the direct influence of the tremor, but to three secondary causes, viz. (1) an increased production of carbon dioxide; (2) a diffusion of nutrient fluids through the soil, acting as a kind of natural manuring; (3) an increased production of electricity. In other instances earthquakes have apparently had an unfavourable influence on vegetation; but this Signor Goiran believes to be due to their having been associated with a long period of drought.

OF the recently published *Indian Museum Notes* one of the most interesting papers is on the wild silk insects of India. It is by Mr. E. C. Cotes, and is intended to serve as a supplement to a previous paper on cultivated silk-producing insects. A small amount of silk is spun by the caterpillars of most moths. The only groups, however, which contain species whose silk is at all suited for utilization are the Saturniidæ and the Bombycidæ, and the whole of the Indian species belonging to these groups, therefore, have been included in the present report, though many of them do not produce sufficient silk to be of any use. So much, however, has of late years been said about the wild silk insects of India, and such exaggerated opinions have been expressed as to their value, that it has been thought best to deal exhaustively with the matter, so as to clear the ground and show precisely how the question really stands.

THE Royal Agricultural and Commercial Society of British Guiana has been discussing the question whether an Agricultural College should not be established in the colony. At a recent meeting Mr. Jacob Conrad brought forward a motion to the effect that a Committee should be appointed to petition the Government on the subject. He failed, however, to obtain the support of a majority. Mr. Darnell Davis thought it desirable that the question should be discussed, but could not see how anything practical would come out of it unless some kind philanthropist found the money. Agricultural Colleges were very expensive, and he did not think the Government could be asked to do anything, as it would mean the imposition of additional taxes. He thought that every sugar plantation in the colony was really an agricultural school.

MRS. ZELIA NUTTALL contributes to the new number of the *Internationales Archiv für Ethnographie* a learned and interesting paper on ancient Mexican shields. She divides them into the following groups:—(1) Plain, unadorned war-shields of several kinds, used by the common soldiery. (2) Gala-shields, indicating the military rank and achievements of chiefs. These seem to have been indiscriminately used in warfare or feasts and dances. Their general structure seems to have been alike in either case, though they may have been more or less light and strong. Shields of this category sometimes reproduced one or more features of the military costume, body-painting, and adornments pertaining to each grade. (3) Shields, presumably of the supreme war-chief, exhibiting in picture-writing the name of his people or his personal appellation. Nothing certain is known about this group, but its existence seems vouched for by a series of indications. (4) Shields pictured in the codices with deities only, exhibiting their emblematic devices or reproducing features of their symbolic attire. Such shields seem to have been carried, in religious dances and festivals, by the living images of the deities in whose honour they were celebrated. (5) Shields of most precious materials, with strange and elaborate designs, described in the inventories. As they are not mentioned elsewhere, it is not possible to state anything definite about them, but it is obvious that they were intended for the use of individuals of supreme rank. The beautiful shield preserved at Castle Ambras, near Innsbruck, belongs to this group. It is the only known specimen with a valid, though shadowy, right to the title of "Montezuma's shield."

ACCORDING to Mr. A. Sidney Olliff, who writes on the subject in the *Agricultural Gazette of New South Wales*, the "metropolis" of the plague locust of New South Wales is in the western district, especially in the great plains between the Lachlan and the Darling Rivers. The breeding-grounds of locusts in Australia are as extensive as those of the Rocky Mountain locust, and are found in similar situations. The eggs are deposited in vast quantities in the earth, close beside one another, frequently over a large tract of country. Usually these breeding-grounds occur in sandy soils or in high dry places, but occasionally they may be found on the banks of a creek. At the end of September last, during a hurried visit to Renmark, in South Australia, Mr. Olliff found the bare sandy banks of a small creek riddled with small holes from which the newly-hatched locusts had but just escaped. Swarms of young locusts had previously been observed by him near Wentworth, making their way from the bare places in which they were hatched to the richer pasturage. The U.S. Entomological Commission has carefully investigated the various ways in which these pests can be most effectually dealt with; and a condensed account of the results is presented by Mr. Olliff for the benefit of Australian farmers.

THE Marine Biological Association, Plymouth, has issued a new price-list of zoological specimens. This cancels the previous list. The specimens are suitable for class or laboratory examination, and for museum purposes. They are kept in stock at the Plymouth Laboratory, and are to be obtained on application to the director.

THE following arrangements have been made for science lectures at the Royal Victoria Hall during April:—April 5, Henry M. Bernard, on "Life in Russia"; April 12, A. H. Fison, on "The Compass Needle"; April 26, Captain Charles Reade, on "The British Navy."

MESSRS. MACMILLAN AND CO. have issued the sixth edition of Sir Henry E. Roscoe's well-known "Lessons in Elementary Chemistry." The fifth edition, which has been repeatedly reprinted with slight corrections, was published in 1886. The author has tried to introduce into the present edition all the

more important discoveries of the last six years, and to make such general improvements as he has thought likely to be of benefit to his readers.

THE April number of *Natural Science*, the new monthly review of scientific progress, has articles on factors in the evolution of the Mammalia, by Prof. C. Lloyd Morgan; some salient points in the study of mammals during 1891, by R. Lydekker; the physical features and geology of Borneo, by F. H. Hatch; great lakes, by Clement Reid; life-zones in Lower Palæozoic rocks, by J. E. Marr, F.R.S.; and a new group of flowering plants, by A. B. Rendle.

MESSRS. KEGAN PAUL, TRENCH, TRÜBNER, AND CO. have issued a second edition of Mr. B. H. Chamberlain's "Things Japanese." The work consists of a number of independent articles, arranged alphabetically, and giving an account of the Japanese people, their country, their ideas, and their industries. It has been enlarged by the insertion of over twenty new articles, while the old have been corrected up to date, and re-written in many parts. The style is compact, fresh, and lucid, and at the end of the more important articles the author gives a list of books in which further information may be obtained. Several subjects have been intrusted to specialists. Prof. Milne contributes the article on "Geology," and Mr. Mason those on "Telegraphs," "Chess," and the game of "Go."

THE "School Calendar" for 1892 has been published, this being the fifth year of issue. Mr. F. Storr, referring in the preface to the movement for the registration of teachers, notes that head masters who have hitherto ignored or sneered at the teaching diplomas of the University of Cambridge are beginning to send up their assistants for the examinations of the Syndicate, or even to enter themselves.

THE new number of *L'Anthropologie* (tome iii., No. 1) opens with an interesting paper on A. de Quatrefages, by Émile Cartailhac. The paper is followed by a useful list of the principal publications by M. de Quatrefages. M. Marcellin Boule contributes some excellent notes on the formation of fossiliferous deposits in caves. There are also papers on the tumulus-dolmen of Marque-Dessus (commune d'Azereix, Hautes-Pyrénées), by General Pothier; on the respective association of anthropological characters, by Dr. R. Collignon; and on the ethnological position of the peoples of Ferghanah, by Paul Gault.

THE U.S. Geological Survey has lately issued a number of important papers in its series of *Bulletins*. One of them (No. 69) contains a classed and annotated bibliography of fossil insects; another (No. 71), an index to the known fossil insects of the world, including Myriapods and Arachnids. No. 72 gives the altitudes between Lake Superior and the Rocky Mountains; No. 74, the minerals of North Carolina; No. 75, a record of North American geology for 1887 to 1889 inclusive; No. 79, an account of a late volcanic eruption in Northern Carolina, and its peculiar lava. No. 76 is the second edition of a dictionary of altitudes in the United States.

WE have received Parts 41 and 42 of Cassell's "New Popular Educator." Both, like the previous parts, are carefully illustrated. In addition to the cuts introduced into the text, Part 41 has a coloured picture of "the Spectre of the Brocken," and Part 42 a coloured map of the Balkan Peninsula.

THE Hunterian Oration, delivered by Dr. J. Hutchinson, F.R.S., in the theatre of the Royal College of Surgeons on February 14 last, has now been published by Messrs. J. and A. Churchill.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. F. D. Lyon; a Rhesus Monkey (*Macacus rhesus* ♀) from India, presented by Mr. J. G. Wythe; a Brush Bronze-winged Pigeon (*Phaps elegans* ♀) from Australia, presented by Mr. H. H. Sharland, F.Z.S.; two Red Kangaroos (*Macropus rufus* ♀ ♀) from Australia, deposited; two Great American Egrets (*Ardea egretta*), two Snowy Egrets (*Ardea candidissima*) from America, two Buff-backed Egrets (*Ardea russata*), European, purchased; an Eland (*Oreas canna* ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE PLANET JUPITER.—During the last year or so the planet Jupiter has been the subject of many observations both at home and abroad. The curious markings that become visible from time to time have been very carefully watched, and the changes which they have been seen to undergo likewise recorded. Those who take a special interest in these observations will find in *L'Astronomie*, under the title of "Recent Discoveries on Jupiter," a most excellent article written by M. Camille Flammarion. The author, after giving a description of the general state of the planet that can be gathered from a telescopic and spectroscopic survey of his surface, adds a *résumé* of the important observations made by M. Terby, at Louvain, which were originally addressed to the Belgian Academy. Many very important facts relating to the positions which the dark and light spots take up are here collated, and the numerous illustrations impress one strongly with the vastness and rapidity of the changes that are continually in progress.

Astronomy and Astro-Physics for March contains also some notes on this planet, communicated by Mr. H. C. Wilson, of the Goodsell Observatory, who, armed with a 16-inch equatorial during the winter of 1891, completed many sketches, some of which are here exhibited. These observations seem to indicate that as the dark belt approached the great red spot which is situated just north of it, the latter appeared to force it to one side, "there being always a very narrow line of white between the belt and spot." This fact seems to show that, whatever the spot may be composed of, it has the power of dissipating the clouds in close proximity to it.

THE OBJECTIVE PRISM.—Prof. Pickering, in the March number of *Astronomy and Astro-Physics*, communicates a very interesting article relative to the method of photographing the spectra of the stars with an objective prism. As an account of this method has already been described in these columns in the review of the catalogue published under the name of "The Draper Catalogue," it is unnecessary for us to enter into the details again. At the latter end of the article he mentions also that "a still further advance will be made with the great photographic telescope, the gift of Miss C. W. Bruce." This instrument is stated to be similar to the "Bache telescope," but three times as large, having an aperture of 24 inches. The spectra of stars down to the 10th and 11th magnitude are expected to be obtained with it. The engraving which accompanies the text illustrates the method of attaching the large prism to the object-glass end of the telescope.

VARIATION OF LATITUDE.—Dr. B. A. Gould, in the *Astronomical Journal*, No. 257, presents us with some of the work which he has been undertaking with regard to the periodic variation of the latitude at Cordoba, from observations made with the meridian circle. The results obtained by Dr. Chandler showed that by assuming a period of fourteen months, the variations in the latitude, determined between the years 1860 and 1875, could be accounted for. Dr. Gould thought that the same period might be found to satisfy the Cordoba observations, and the computations that he has made form the subject of the present inquiry. Owing to the fact that this number of the *Journal* does not contain the whole of the work (the latter part of which will be concluded in the next one), we are not able to give the results which he has obtained, but we can mention a point that seems of importance, and which tends to corroborate Dr. Chandler's results.

In a table showing the mean excess of the calculated, above the observed, declinations, the author remarks that "there are two facts which attract attention: first that the times of maxima and minima of the curve are approximately coincident with those deduced by Dr. Chandler from contemporaneous observations in other places; and, secondly, that the corresponding

periodical fluctuations of the curve are markedly inferior to other and larger variations upon which they appear superposed. . . The range included between these extremes amounts to two seconds, and is altogether too large to be attributed either to personal equation or to any instrumental origin."

THE DISCOVERY OF NEPTUNE.—During a visit to England, in 1876, Prof. Holden was frequently with Mr. Lassell, and he then learned a circumstance connected with the discovery of Neptune which is not without interest. Now that Adams and Lassell are both gone, Prof. Holden has published the brief notes he made at the time, as a contribution to the history of the great discovery. It is well known that, in October 1845, Adams submitted to the Astronomer-Royal his computations indicating the existence of an unknown world beyond Uranus. The work was shown to Dawes, and he was so much impressed by it that he wrote to Lassell, asking him to search for Neptune in the region designated by Adams. Had the discoverer of the two inner and faint satellites of Uranus, and the satellite of Neptune, directed his 2-foot reflector to this region, there is little doubt but that the planet would have been picked up. However, the Fates ordained otherwise: Lassell was confined to his sofa by a sprained ankle, and, when he recovered, the letter of Dawes, giving the predicted place of Neptune, could not be found. It turned out to have been destroyed by a too-zealous maid-servant. Thus, "by a set of curious chances," the new planet was never looked for by the then most powerful telescope and most skilful observer in England. It was not until many months after the letter of Dawes to Lassell that the planet was found by Galle and D'Arrest, near the position given by Leverrier.

ASTRONOMY AT THE PARIS ACADEMY, MARCH 21.—At the meeting of the Paris Academy of Sciences, on March 21, M. Lœwy presented a picture of the Orion Nebula obtained at Toulouse Observatory, with an exposure of five hours, on February 24, 25, and 26.

M. Bigourdan observed Swift's comet on March 17, 18, 19, and 20, and determined its position. He describes it as "a bright nebulosity, 2′ in diameter, without a tail, and with a well-defined stellar nucleus, the light of which is comparable with that of a star of the eighth or ninth magnitude." Denning's comet was seen on March 19 and 20, and five observations of position were made. It is described as "a feeble nebulosity without a tail, 25″ to 30″ in diameter, brighter towards the centre, but without any apparent nucleus. Its light was at the most equal to that of stars of magnitude 13." M. Rayet observed Swift's comet on March 17 and 19, and estimated that its nucleus was of the sixth or seventh magnitude.

M. Terby, in a letter to M. Faye, claims priority for the idea that solar spots and other disturbances on the sun exert an influence on terrestrial magnetism and electricity which varies according to the position of the phenomena with reference to the sun's visible disk. In a paper presented to the Brussels Academy in 1883, "On the Existence and Cause of a Monthly Periodicity of Auroræ," he showed that the fluctuations in frequency of auroræ were connected with the period of the sun's synodic rotation. Hence, some portions of the solar surface seem more capable of exerting terrestrial influence than others.

VARIABILITY OF NEBULÆ.—In NATURE of January 14 (p. 261) some observations were described which seemed to indicate that a nebula in R.A. 3h. 36m., Decl. 95° 2′·1, was variable. Dr. Lewis Swift notes, in *Astronomy and Astro-Physics*, that he has again looked for the nebula, and on January 31 succeeded in getting two glimpses of it, using a power of 195. Although Dr. Swift is not inclined to believe that the nebula is variable, it is strange that he should at one time have picked up the object whilst sweeping, and yet not be able to find it afterwards, even with the most persistent searching. That Dr. Dreyer, also, should have failed to see the nebula on several occasions, although he knew where and what to look for, is almost unaccountable, if the brightness is uniform. It is to be regretted that the illumination of the sky at Rochester, from the electric lights, seems likely to prevent Dr. Swift from continuing his search for nebulæ.

SOLAR PROMINENCE PHOTOGRAPHY.—As the great spot-group of February was again coming round the sun's east limb on March 3, M. Deslandres observed over it a prominence. He also photographed it, and, at the meeting of the Paris Academy of March 14, communicated the results obtained. The Fraunhofer lines H and K are very bright on the photographs, and the entire series of ultra-violet hydrogen lines are plainly visible. Other lines are seen which have not previously been recognized as chromosphere lines, viz. the magnesium triplet about λ 383, and lines at $\lambda\lambda$ 375·93, 376·14, and 368·53, the origins of which are unknown.

THE AURORA SPECTRUM.—The aurora of February 13 was seen at Chicago, and Prof. Hale made some observations of its spectrum, using a small direct-vision spectroscope. A bright band was made out in the red, near C, and another was identified as the characteristic aurora-line. A very faint line, broad and hazy, appeared in the green, near the position of *b*, and a faint one near F.

THE PROPERTIES OF AMORPHOUS BORON.

THE properties of pure amorphous boron form the subject of a contribution to the current number of the *Comptes rendus* by M. Moissan. In our chemical note of March 3 (p. 421), the method was described by which M. Moissan has recently succeeded in preparing the amorphous form of boron in a state of almost perfect purity. The method consisted in reducing an excess of boric anhydride with powdered metallic magnesium, and subsequently repeatedly extracting the soluble products by acids. He now proceeds to describe the physical and chemical properties of the element as thus obtained. Pure amorphous boron is a fine chestnut-coloured powder, which may be readily moulded into adhesive masses by pressure. Its density is 2·45. It is infusible, even at the temperature of the electric arc. When heated in the air to a temperature in the neighbourhood of 700°, it inflames, and burns with formation of boric anhydride. If a small quantity is heated strongly in a test-tube, and, while hot, thrown into the air, a host of brilliant sparks are produced. When the powder is heated in a current of oxygen it burns with an intensely luminous flame, which, when the experiment is performed in a dark room, is observed to possess a green tint. The rays emitted are almost devoid of actinic power, the greater portion of the chemically active end of the spectrum being wanting. Pure amorphous boron reacts in a beautiful manner with sulphur at a temperature of about 610°, brilliant incandescence occurring with production of sulphide of boron. This latter substance is decomposed by water with liberation of sulphuretted hydrogen. Selenium reacts with amorphous boron in an analogous manner at a higher temperature, but without incandescence, the selenide of boron produced evolving hydrogen selenide when brought in contact with water. Tellurium, however, may be fused in presence of boron without any reaction occurring.

When amorphous boron is heated in an atmosphere of chlorine to 410°, combination accompanied by bright incandescence occurs with formation of chloride of boron, which, if the experiment is performed in a suitable apparatus, distils over into a receiver placed to intercept it. Bromine combines with boron to form the liquid bromide of boron at a temperature approaching 700°, the reaction likewise being accompanied by incandescence. Even bromine water attacks boron, although slowly, at the ordinary temperature, and an aqueous solution of bromine in potassium bromide attacks it rapidly. Iodine appears to be without action even at a red heat. Amorphous boron only combines directly with nitrogen at a high temperature, mere traces of the nitride being produced at temperatures below 900° when the powder is heated in a current of nitrogen; but at about 1200° combination rapidly occurs. The vapours of phosphorus, arsenic, and antimony do not react at available temperatures. When amorphous boron is heated in the electric arc in an atmosphere of hydrogen, boride of carbon is formed with a portion of the carbon of the poles.

The behaviour of metals towards amorphous boron is somewhat singular. The alkali metals may actually be distilled over the powder without any apparent trace of combination. Magnesium, on the contrary, combines with boron to form a boride at a low red heat. Iron and aluminium also form borides at a red heat, and silver and platinum react with even greater facility.

Acids react with amorphous boron with considerable energy. At 250° sulphuric acid is reduced to sulphur dioxide. Nitric acid in small quantities produces incandescence. Phosphoric anhydride is reduced at 800° to phosphorus. Arsenious and

arsenic acids are reduced at low redness with sublimation of annuli of arsenic. When the powder is dropped into a warm solution of iodic acid, iodine is liberated, and if a mixture of amorphous boron and crystallized iodic acid is slightly warmed, it takes fire, and a cloud of iodine vapour is produced. Gaseous hydrofluoric acid attacks amorphous boron at low redness, hydrogen being liberated, and fluoride of boron produced. Hydrochloric acid only reacts at bright redness.

Steam does not react with boron below a red heat, but the moment incandescence commences at any point the decomposition proceeds with explosive violence, hydrogen being liberated and boric anhydride produced. Carbon monoxide is reduced by boron at 1200°, with formation of boric anhydride and deposition of carbon. When amorphous boron is heated to low redness in a current of nitrous oxide, incandescence is produced, and boron nitride and boric anhydride are formed. Nitric oxide, however, does not react with boron under these circumstances.

Metallic oxides are much more readily reduced by boron than by carbon. For instance, when a mixture of copper oxide and amorphous boron is heated in a glass test-tube, the heat produced in the act of reduction is so great that the glass immediately fuses. Oxides of tin, lead, antimony, and bismuth are immediately reduced upon slightly warming, and the mass becomes white hot. When peroxide of lead is rubbed in a mortar with amorphous boron, a violent detonation occurs. Oxides of iron and cobalt are reduced at a red heat, but the alkaline earths are not attacked by boron. When caustic potash is fused in contact with amorphous boron, a vigorous reaction occurs, with rapid evolution of hydrogen.

The great affinity of boron for oxygen may be readily shown by making a gunpowder in which carbon is replaced by boron; if such a mixture of amorphous boron, sulphur, and nitre is made, it will be found to explode considerably below the lowest red heat. If a few particles of amorphous boron are allowed to fall into fused potassium chlorate, quite a pyrotechnic display is produced. The behaviour of certain fluorides towards amorphous boron is interesting. Silver fluoride, for instance, reacts in the cold upon simple contact in a mortar, with incandescence and detonation. Many other fluorides are similarly decomposed on warming.

Sulphates of potassium and sodium are reduced to sulphides at a low red heat by amorphous boron with great energy, the mass becoming white hot. Fused nitre, however, only reacts at the temperature at which oxygen commences to be evolved, but fused nitrites of the alkali metals react with violence, and production of light and heat. Sodium carbonate, moreover, is reduced at the temperature of low redness with vivid incandescence. The reducing capabilities of boron appear to be even manifested in presence of water, for the powder rapidly decolorizes a solution of permanganate, and reduces solutions of ferric salts to ferrous. Silver nitrate in solution is reduced with deposition of crystals of metallic silver; gold chloride also yields an immediate precipitate of finely divided gold, and platinum chloride is likewise reduced with precipitation of platinum upon warming.

A. E. TUTTON.

THE MANCHU RACE.

THE origin of the Manchus—the race to which the reigning dynasty in China belongs—is discussed by a writer in the *North China Herald*, of Shanghai. He says that the Tungus people are scattered about in Siberia and Manchuria in rather small communities of several hundreds or thousands each. In 1854 there were about thirty-five or forty thousand persons altogether in Siberia belonging to this race. Being hunters and fishers they find it best to live on the banks of rivers and on the seaside for fishing, and in wooded hill countries for hunting. They are met with, consequently, on the shores of the Baikal, and on the upper waters of the Lena, which rises among the mountains west of that inland sea. These few colonies of this race are under the jurisdiction of Irkutsk. Still farther west there are a tribe or two on the Yenissei. Those on the Lena are near the part where the mammoth and other wild animals formerly had their haunts. The frozen remains of these ancient creatures are found chiefly at the mouth of the Lena, which flows north to the Arctic Sea through about twenty degrees of latitude from the neighbourhood of Baikal. On the east of the Baikal, Nerchinsk and the banks of the Orchon and Onon Rivers are preferred by this people, who are irregularly scattered among the Buriat tribes in this part of Siberia. In the Amur territory of Russia they occupy parts of the sea coast, and are known as the Orotches and Goldi. It is because the salmon and other fish that they live on are found in abundance that they here build their movable huts. In the Russian Amur province there are about forty thousand of them, representing an ancient race which, as their language, joined with the facts of Chinese history, shows, must have occupied these same territories and prosecuted these occupations for thousands of years. In Kirin province there are, it is likely, a corresponding number, for the trade with China always demands sable skins, otter skins, squirrel skins, beavers, ermines, and fox skins in an ever-increasing quantity. It is this demand for skins that maintains the tribes in the north part of Kirin province residing on the banks of the Usuri and other streams which flow north into the Amur.

The Tungus tribes to which the Manchus belong first appear in history in the Chow dynasty. They are the Sokdin or Sushen of that age, and they were powerful in the eleventh century before our era. They are mentioned in the preface of the Book of History, so that we have next to classical authority for their existence at that distant period as a powerful state. The historian Tso mentions them in the sixth century, and from the way in which he speaks they were the strongest race in Tartary at the time. But in the third century, after nine hundred years of honour, their star went down, and the age of Turkish ascendency arrived. The Hiung-nu Turks of the Han dynasty had emperors of their own, who at least on one occasion were received in China on terms of equality with the haughty sovereigns of their southern neighbours. They could call themselves eldest sons of heaven and brothers of the sun and moon, just as the Chinse could, and therefore they did so. But their star also went down. The Turkish race has been used to rule wild tribes for 2000 years. We know that the Hiung-nu were Turks by the words left of their vocabulary which are found recorded in Chinese history. But their power declined, and then the Sushen, or Tungus, rose again to influence, and it was because they lived in the eastern provinces, where the valleys are rich in productive power, and because they had the good sense to profit by Chinese teaching. When China conquered the Moukden province and Corea, a century before the Christian era, the result was that the habits of life of the Chinese and their moral and intellectual activity spread to the east and north-east. Tungus and Corean tribes came under this new influence, and grew more powerful in proportion to the progress they made in the adoption of a civilized life. The Tungus Ambassadors arrived at Loyang in A.D. 263 and 291; and a few years later, when the Tsin Emperor had removed his Court to Nanking, they appeared there. Probably they came from the mouth of the Newchwang River by sea, for we know that the Chinese junk-masters navigated the Gulf of Pechili fully 2000 years ago. The troops which subjugated Corea at that time were there in large junks. Meanwhile other branches of the Tungus race had become sufficiently powerful to disturb the quiet of North China. Among them were the Owan and Sien Pi. The Sien Pi and the Hiung-nu conquered large portions of Chinese territory. The Tungus people ruled in the province of Peking. The Turks occupied Shansi, and Tibetan tribes took possession of Shensi. Each of these races seized on that part of North China which lay contiguous to their homes in Tartary. This state of things lasted till the latter part of the fifth century, when the Chinese drove the Tartars out. Again, however, at the beginning of the twelfth century a Tungus race conquered North China, and was followed later by a Mongolian dynasty, to which the Chinese of north and south all submitted for a hundred years.

The Mongols as a race are probably an offshoot from Tungus stock. There are differences, but there is on the whole a great resemblance. The consanguinity that exists between Manchu and Mongol is greater than that which is found to prevail between Mongol and Turk; and therefore it may be concluded that the Tungus, either in Siberia or in Manchuria or on the Amur, threw off a branch which became Mongol. This would be of a very ancient date, for otherwise the grammars of the Mongol and Manchu would be more alike than they are. Genghis Khan and his tribe started on the conquest of the Asiatic continent from the neighbourhood of the gold mines in Nerchinsk, and the Mongols are not fishermen by preference nor hunters of the sable martin and the beaver. They are rather keepers of sheep and riders of horses and camels. They

might easily develop their language in the vicinity of the Altai Mountains and the Baikal.

As to the Manchus, they have forgotten their early occupations since coming to China, and they attend now only to the duties of the public service or to military training. The language, like the Mongol, is rich with the spoils of antiquity. All the various forms of culture, whether belonging to Shamanism, Confucianism, or Buddhism, with which they have become successively familiar, have contributed a share. To these must be added the vocabulary of the huntsman, the fisherman, and the shepherd, and all the terms necessary for the feudal relationship as well as those of the trades and occupations of the old civilization.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, March 11.—Prof. A. W. Rücker, F.R.S., Vice-President, in the chair.—Mr. H. M. Elder read a paper on a thermodynamical view of the action of light on silver chloride. In the decomposition of silver chloride by light, chlorine is given off, and a coloured solid body of unknown composition (sometimes called "photochloride") formed, the reaction being indicated by the formula $n\mathrm{AgCl} = \mathrm{Ag}_n\mathrm{Cl}_{n-1} + \frac{1}{2}\mathrm{Cl}_2$. If the experiment be carried out in a sealed vacuum, the chloride is darkened up to a certain point, but regains whiteness when left in the dark. These facts have led the author to believe that the pressure of the liberated chlorine is a function of the illumination or intensity of light falling upon the chloride, in the same way as the pressure of a saturated vapour is a function of the temperature. Since illumination is a quantity in many respects analogous to temperature, he considers it not unreasonable to apply thermodynamic arguments, and regard chlorine in presence of silver chloride and "photochloride" as the working substance in a "light engine." He therefore supposes a Carnot's cycle to be performed on the substances at constant temperature, the variables being pressure, volume, and illumination. Since the cycle is strictly analogous to Carnot's, except that illumination is written for temperature, he infers that the efficiency is a function of the two illuminations. It also follows that just as Carnot's cycle is used to determine an absolute scale of temperature, so this cycle may be applied to determine an absolute scale of illumination. It only remains to determine an empiric scale analogous to the air thermometer, and to compare it with the photodynamic scale, provided a method of making the comparison can be devised. Assuming the axioms applied to Carnot's cycle are true when illumination is written for temperature, the author shows mathematically that $p \propto \mathrm{I}^{\rho/\mathrm{T}}$, where p is the pressure, I the illumination, T the absolute temperature, and ρ the heat of combination per gramme-molecule of chlorine evolved. If P be the heat of formation of silver chloride, the fraction ρ/P may be considered as expressing the fraction of the total chlorine that can be removed by the action of light upon it, supposing the gas removed so as to keep the pressure below that corresponding to the illumination. The chemical equation might then be written—

$$\mathrm{P}/\rho\mathrm{AgCl} = \mathrm{Ag}_{\mathrm{P}/\rho}\,\mathrm{Cl}_{\mathrm{P}/\rho - 1} + \tfrac{1}{2}\mathrm{Cl}_2;$$

thus the formula for "photochloride" would be $\mathrm{Ag}_{\mathrm{P}/\rho}\mathrm{Cl}_{\mathrm{P}/\rho - 1}$. Prof. Rücker read a letter from the President (Prof. Fitzgerald) on the subject of the paper. He inquired what axiom corresponding with the second law of thermodynamics was employed. He was not sure that the engine was perfectly reversible, and felt doubt on the subject of phosphorescence mentioned in the last operation of the cycle. Nevertheless, the paper was a most interesting one, and very suggestive. Prof. Herschel pointed out that Becquerel's phosphoroscope showed that all kinds of light produced phosphorescence, and thought that, in considering the subject, the non-thermal character of photogenic light should be kept in view. Mr. Baker said he had been working on silver chloride for several years, and found that no darkening whatever took place if kept dry and *in vacuo*. He considered oxygen necessary to the action. Dr. C. V. Burton, referring to the motivity of the system, said that only a small fraction of the energy of the illumination was actually made use of. He also thought it necessary to consider how far the second law of thermodynamics could be treated as an axiom. He himself had been led to believe the law did not hold for mixtures of substances differing in a finite degree from one another. Some time ago he experimented on a solution of sodium sulphate placed in a dialyzer kept at constant temperature. The more acid portion passed through the membrane, and on mixing a rise of temperature was observed; the dialyzer thus acted like Maxwell's demons, and the mixing increased the motivity of the system. Prof. Rücker expressed his doubts as to whether the cycle described in the paper was strictly analogous to that in Carnot's problem. In the latter case the parts of the working substance only differed infinitesimally from one another, whilst in the former the working body was a mixture of two solids and a gas. In order that the increased illumination should not alter the temperature, heat must be carried away. According to the paper, the first part of the cycle must be both adiabatic and isothermal. This seemed hardly possible. If the chlorine alone be considered, it could not be true, and it could only hold if the chloride absorbed all the heat given out by the compression of the chlorine. This seemed improbable, but, if true, it would be very important. Captain Abney saw another difficulty in the fact that at low temperatures silver chloride is not acted on even by violet light, whereas heating greatly increases the action. In his opinion the conclusions arrived at required confirmation, but the paper would form a starting-point for many new experiments. Mr. Elder, in reply to Prof. Fitzgerald, said the axiom corresponding to the second law as stated by Clausius might be formulated thus: Energy cannot of itself pass from a less bright to a brighter body. In the paper he had assumed that the energy given out during compression at the lower illumination was of the same quality as that absorbed at the higher. The whole question depended on comparisons of intensities of illuminations of different wave-lengths. In the expression $p \propto \mathrm{I}^{\rho/\mathrm{T}}$, ρ was probably a function of T, and Captain Abney's objection was not necessarily fatal. Speaking of the presence of oxygen being essential to decomposition, he believed some sensitizing body was necessary, but judging from experiments he had seen, an infinitesimal quantity would probably be sufficient, for the action seemed to be of a catalytic nature. He felt the weight of Prof. Rücker's objections, but thought they might possibly be met.—A paper on choking coils was read by Prof. Perry, F.R.S. Regarding a choking coil as a transformer with one primary and many secondaries represented by the conducting masses, he pointed out that all the secondaries might be replaced by a single coil of n turns, and resistance r ohms, short-circuited on itself. Assuming no magnetic leakage, the equations for the two circuits at any instant are $\mathrm{V} = \mathrm{RC} + \mathrm{N}\dot{\theta}\mathrm{I}$, and $\mathrm{O} = rc + n\theta\mathrm{I}$, where N and n are the turns, R and r the resistances, I the total induction (in 10^8 C.G.S. lines), and C and c the primary and secondary currents respectively. Since the exciting current, C, is all-important in choking coils, and its value depending on the law of magnetization, the equations are treated in a different manner from that adopted in ordinary transformer calculations. Expressing the magnetic law as a Fourier series, $\mathrm{I} = \Sigma\, \mathrm{A}_i\sigma_i \sin ix$, the value of A (viz. $\mathrm{NC} + nc$) is deduced, and when V or I is given as a periodic function of the time, C may be calculated. Assuming $\mathrm{V} = \mathrm{V}_0 \sin kt$, the author finds

$$\mathrm{C} = \frac{\mathrm{V}_0}{\mathrm{N}^2\sigma k}\left[\sqrt{1 + 2e\sin f + e^2}\,.\,\sin\left\{kt - 90 + \tan^{-1}\left(\tan f + \frac{e}{\cos f}\right)\right\} - b\cos 3kt - m\cos 5kt\right],$$

where $e = n^2\sigma k/r$, f is the hysteresis term, and b and m constants depending on the law of magnetization. For ordinary transformer magnetizations, $b = 0{\cdot}2$, and $m = 0{\cdot}05$. From the above expression it will be seen that if there is no hysteresis (*i.e.* $f = 0$), the effect of the eddy currents, e, is to increase the amplitude of the important term, and to produce a lead of $90^\circ - \cot^{-1}e$, whereas the effect of hysteresis without eddy currents is to leave the amplitude unaltered, and produce a lead f. Putting $f = 0$ gives results in accordance with experimental observation, hence the author is inclined to believe that there is no hysteresis in transformers. He also points out that the higher harmonics must exist, and thinks it probably that a choking coil with finely divided iron may prove a method of increasing frequency by mere magnetic means. Taking the case of a 1500-watt transformer (2000 volts) unloaded, in which the loss in eddies was 40 watts, it is shown that a secondary of 2 turns, and resistance 1·9 ohms, would replace the eddy

current circuits. Assuming constant permeability and no eddy currents, the value of C comes out $0{\cdot}07398 \sin (kt - 90°)$, whilst with eddy currents and some saturation

$$C = 0{\cdot}07911 \sin (kt - 69°{\cdot}2) - 0{\cdot}014796 \cos 3kt - 0{\cdot}003695 \cos 5kt.$$

Dr. Fleming said he was working on the subject of choking coils, and had found that, in closed-circuit transformers unloaded, the real watts were about 0·7 times the apparent watts. This, on the assumption of sine functions, would indicate a lag of about 45°. A similar rule for open-circuit transformers was much needed. It was important to know what size of core and coil was required to choke down to a given current. Dr. Sumpner thought it better to treat the subject graphically rather than by analysis, and described a construction whereby the fundamental equations could be readily integrated. Prof. Perry said he had reason to think that ordinary hysteresis curves were not applicable to transformers. By analysis of the experimental E.M.F. and current curves, one could work backwards and find the true hysteresis curves.

Chemical Society, March 3.—Prof. A. Crum Brown, F.R.S., in the chair.—An address was read, which it is proposed to present to Prof. Bunsen, who has now been for fifty years a foreign member of the Society.—The following papers were then read:—A rule for determining whether a given benzene mono-derivative shall give a meta-di-derivative or a mixture of ortho- and para-di-derivatives, by Prof. A. Crum Brown and Dr. Gibson. If a benzene mono-derivative be converted into a di-derivative by replacement of a second atom of hydrogen in the nucleus by a radicle of the same kind as the one already present, the product may consist either of the meta-di-derivative or a mixture of ortho- and para-di-derivatives. The authors suggest a rule for determining which of these two cases will result in any instance. If the hydride of the radicle employed is directly convertible into the corresponding hydroxide, the meta-di-derivative will be obtained on further substitution by the same radicle. If the hydride of the substituting radicle is not directly oxidizable to the hydroxy-compound a mixture of ortho- and para-di-derivatives will result. For example, when the substituting radicle is chlorine, as in the case of monochlorobenzene, hydrogen chloride not being directly oxidizable to hypochlorous acid, the rule indicates that a mixture of ortho- and para-di-derivatives will be obtained on further chlorination. Nitrous acid is readily converted by direct oxidation into nitric acid, so that on nitration of nitrobenzene, meta-dinitrobenzene alone should be produced if the rule be a correct one. In these, as in the other cases cited by the authors, the rule is found to hold good.—The relative orienting effect of chlorine and bromine; (1) The constitution of parabrom- and parachloranilinesulphonic acids, by H. E. Armstrong and J. F. Briggs. Parachlorobromobenzene on sulphonation yields one sulphonic acid, $C_6H_3 . Br. Cl. SO_3H$, possessing the constitution $Cl : SO_3H : Br = 1 : 2 : 4$. The authors were unable to obtain two sulphonic acids on sulphonating parachloraniline; only one was produced, which separates from its aqueous solution in three distinct forms. This also holds true for the sulphonation of parabromaniline, the sulphonic acids having the constitution Cl or $Br : SO_3H : NH_2 = 1 : 2 : 4$.—Note on anhydrides of sulphonic acids, by H. E. Armstrong. When para-dichloro-, chlorobromo-, and dibromobenzene are treated with sulphuric acid containing about 20 per cent. of sulphuric anhydride, sulphonic anhydrides are obtained. These compounds probably owe their formation to the dehydration of the corresponding sulphonic acids first formed.—Contributions to the knowledge of the aconite alkaloids; Part II. The alkaloids of true *Aconitum napellus*, by W. R. Dunstan and J. C. Umney. The roots of true *Aconitum napellus* were extracted with cold fusel oil. The solution so obtained was, after some preliminary treatment, extracted with ether. Two alkaloids were thus extracted, and were separated by means of their hydrobromides into a crystalline and a gummy alkaloid. The former of these was found to be aconitine, whilst the non-crystallizable compound is a new alkaloid which the authors term napelline. This alkaloid is soluble in ether and alcohol, and has a very bitter taste, but does not give rise to the tingling sensation so characteristic of aconitine. Its salts could not be crystallized. By further extraction of the fusel oil with chloroform, aconine was obtained. The roots of true *Aconitum napellus*, therefore, must be held to contain three alkaloids, one of which, viz. aconitine, is crystalline, whilst two are amorphous, viz. napelline and aconine. Indications have been obtained of the presence of a fourth alkaloid, which is amorphous and closely resembles napelline. Aconitine is by far the most toxic of the alkaloids contained in *Aconitum napellus*.—Contributions to our knowledge of the aconite alkaloids; Part III. The formation and properties of aconine and its conversion into aconitine, by W. R. Dunstan and F. W. Passmore. When pure aconitine is hydrolyzed by heating it with water in closed tubes at 150°, aconine and benzoic acid are obtained in accordance with the following equation—

$$C_{33}H_{45}NO_{12} + H_2O = C_{26}H_{41}NO_{11} + C_7H_6O_2;$$

no picraconitine or methyl alcohol is obtained at any stage. Anhydro-aconitine is formed by the interaction of aconine and ethyl benzoate at 130°, leaving no doubt that aconitine is benzoyl-aconine. Aconine yields a crystalline hydrochloride, $C_{26}H_{41}NO_{11}, HCl, 2H_2O$, whose specific rotatory power $[\alpha]_D = -7°{\cdot}71$. Pure aconine is a hygroscopic, brittle gum, having the composition $C_{26}H_{41}NO_{11}$, and the rotatory power $[\alpha]_D = +23°$. Its solution reduces Fehling's solution and gold and silver salts. Its aqueous solution is slightly bitter, and gives rise to a burning sensation in the mouth. A crystalline aconitine methiodide, $C_{33}H_{45}NO_{12}, CH_3I$, and an amorphous methydroxide, $C_{33}H_{45}NO_{12}, CH_3 . OH$, have been prepared. A simple laboratory shaking appliance, devised by Prof. Dunstan and Mr. Dymond, was exhibited at the conclusion of this paper.—Note on the carbon deposited from coal-gas flames, by W. Foster. The author quotes analyses of cokes obtained by carbonizing sugar and starch. From the similarity in composition of these cokes to that of the soot obtainable from coal-gas flames, he is of opinion that these substances are all formed by somewhat similar chemical processes.—The volumetric estimation of mercury, by Chapman Jones. The author has devised a modification of the cyanide method of estimating mercury.—Chromic acid, by Eleanor Field. Results are quoted showing that the crystals obtained on cooling with ice a solution of chromium trioxide saturated at 90° consist merely of the trioxide, CrO_3, and not of chromic acid, H_2CrO_4, as stated by Moissan.—The origin of acetylene in flames, by V. B. Lewes. The author has sought to determine whether acetylene is the product of high temperature change or of oxidation. The experiments described consisted in passing hydrocarbon gases and mixtures of such gases with others through a heated platinum tube. The results obtained appear to point to acetylene being formed by the action of heat alone.

Geological Society, March 9.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—The new railway from Grays Thurrock to Romford: sections between Upminster and Romford, by T. V. Holmes. In the Hornchurch cutting of the new railway, boulder clay, of which about 15 feet is seen, rests upon the London Clay near the 100-feet contour-line, and is overlain by 10 to 12 feet of sand and gravel. The author gives reasons for inferring that this sand and gravel belongs to the oldest terrace of the Thames Valley gravel occurring in this district, and states that it demonstrates the truth of Mr. Whitaker's conclusion that the Thames Valley deposits are (locally) post-Glacial, or newer than the local boulder clay. After the reading of this paper the President said that geologists were much indebted to Mr. Holmes for drawing attention to this interesting section before it was too late. Amongst the many points arising from the discovery of boulder clay at less than 100 feet above Ordnance datum was one as to the probability of the pre-Glacial age of the Thames Valley system. Mr. H. B. Woodward, Mr. H. W. Monckton, Mr. C. Reid, Dr. Hicks, Mr. Lewis Abbott, and Mr. Whitaker also spoke.—The drift beds of the North Wales and Mid-Wales coast, by T. Mellard Reade. This paper is a continuation of papers by the author on the drift beds of the north-west of England and North Wales. The author first treats of the Moel Tryfaen and other Caernarvonshire drifts; he describes the drifts of the coast and coastal plain, connecting his observations with those of the Moel Tryfaen drifts. An important feature of the investigation is the numerous mechanical analyses of the various clays, sands, and gravels. In all the samples but one, a large proportion of extremely rounded and polished quartz-grains have been found, which the author maintains to be true erratics, and a certain sign of marine action. He shows that the Moel Tryfaen marine sands are in part overlain by typical till, composed almost wholly of local rocks with a small percentage of clay, whereas the sands and gravels are full of erratics, including rocks from Scotland and the Lake District, numerous flints, Carboniferous Limestone, and

crystalline schists. Throughout the drifts of the coastal plain he has found a greater or less proportion of granite erratics, as well as, in many cases, minute rolled-shell fragments. He maintains that these drifts are the result of two opposing forces, one radiating from Snowdonia, and the other acting from the sea to the southwards, and their characteristics change as the one or the other force preponderated. The other divisions of the paper are taken up with a description of the Merionethshire drift and that of Mid-Wales, numerous sections being given. Attention is called to a remarkable glaciation of the rocks at Barmouth. In a concluding part, giving inferences and suggestions, the author discusses the land-ice and submergence hypotheses, and concludes that his observations distinctly strengthen the grounds for believing in a submergence of the land to an extent of not less than 1400 feet. An appendix contains details of nineteen mechanical analyses of tills, sands, and gravels, and a bibliography of papers, observations, and theories of the high-level drifts of Moel Tryfaen. The reading of this paper was followed by a discussion, in which Mr. Lamplugh, Mr. J. W. Gregory, Mr. H. W. Burrows, the President, and others took part.

Zoological Society, March 15.—Prof. W. H. Flower, F.R.S., President, in the chair.—Mr. Sclater exhibited and made remarks on the skin of a Wild Ass obtained by Mr. J. D. Inverarity in Somali-land.—A report was read, drawn up by Mr. A. Thomson, the Society's Head Keeper, on the insects bred in the Insect-house during the past season.—Mr. Seebohm exhibited and made remarks on two pairs of *Picus richardsi* from the island of Tsusima in the Japanese Sea.—Mr. Oldfield Thomas exhibited and described a head (placed at his disposal by Messrs. Rowland Ward and Co.) of the East African *Oryx*. This Antelope, commonly supposed to be *O. beisa*, was shown to differ from that species in possessing long black tufts on the tips of its ears. It was proposed to be called *O. callotis*.—Dr. H. Gadow read a paper on the classification of Birds, in which the results arrived at, after a long study of the structure of Birds for the purpose of completing the part "Aves" of Bronn's "Thierreich," were set forth.—A communication was read from Mr. C. Brunner v. Wattenwyl and Prof. J. Redtenbacher, containing a report on the Orthoptera of the island of St. Vincent, West Indies, collected by Mr. H. H. Smith, the naturalist sent to that island by Mr. Godman, in connection with the operations of the Committee appointed by the British Association and Royal Society for the investigation of the fauna and flora of the Lesser Antilles.—Mr. Oldfield Thomas read a paper on a collection of Mammals from Mount Dulit, in North Borneo, obtained by Mr. Charles Hose. Fourteen species were represented in the collection, of which four were stated to be new to science. Amongst these was a new Carnivore of the genus *Hemigale*, proposed to be called *Hemigale hosei*.—Dr. R. Bowdler Sharpe gave the description of some new species of Timeliine Birds from West Africa.

Entomological Society, March 9.—Mr. Frederick DuCane Godman, F.R.S., President, in the chair.—Prof. C. Stewart exhibited and made remarks on specimens of *Cystocœlia immaculata*, an Orthopterous insect from Namaqualand, in which the female is far more conspicuously coloured than the male, and the stridulating apparatus of the male differs in certain important details from that of other species. A long discussion ensued, in which Dr. Sharp, F.R.S., Mr. Poulton, F.R.S. Mr. Distant, Mr. H. J. Elwes, Colonel Swinhoe, and Mr. Hampson took part.—Mr. Elwes exhibited specimens of *Ribes aureum* which were covered with galls, as to the nature of which the Scientific Committee of the Horticultural Society desired to have the opinion of the Entomological Society. Mr. Fenn, Mr. Tutt, and Mr. Barrett made some remarks on these galls.—Mr. Elwes also exhibited a large number of species of Heterocera recently collected by Mr. Doherty in South-East Borneo and Sambawa. Colonel Swinhoe, Mr. Hampson, and Mr. Distant took part in the discussion which ensued.—Mr. Barrett exhibited a series of specimens of *Noctua festiva*, bred by Mr. G. B. Hart, of Dublin, which represented most of the known forms of the species, including the Shetland type and the form formerly described as a distinct species under the name of *Noctua conflua*. Mr. Fenn and Mr. Tutt made some remarks on the specimens.—Mr. W. C. Boyd exhibited a specimen of *Dianthecia Barrettii*, taken at Ilfracombe last summer. It was remarked that Mr. W. F. H. Blandford had recorded the capture of *D. Barrettii*—which had until recently been supposed to be confined to Ireland—from Pembrokeshire, and that its capture had also since been recorded from Cornwall.—Mr. Tutt exhibited specimens of *Polia xanthomista* from Mr. Gregson's collection, which had recently been sent to him by Mr. Sydney Webb.—Mr. G. A. James Rothney exhibited and read notes on a large collection of Indian ants which he had made in Bengal between 1872 and 1886, comprising some ninety species. He stated that eighteen of these species had been described by Dr. Mayr in his paper entitled "Ameisen Fauna Asiens," 1878: he also said that Dr. Forel had recently identified several other new species in the collection, and that there were about ten species and one new genus which Dr. Forel had not yet determined.—Mr. H. Goss exhibited, for Mr. T. D. A. Cockerell, of Kingston, Jamaica, several specimens of palm leaves, from the garden of the Museum in Kingston, covered with *Aspidiotus articulatus*, Morgan. The leaves appeared to have been severely attacked, the scales entirely covering the upper surface in places.—Mr. F. D. Godman contributed a paper by the late Mr. Henry Walter Bates, with an introduction by himself, entitled "Additions to the Longicornia of Mexico and Central America, with remarks on some previously-recorded Species."—The Rev. A. E. Eaton communicated a paper entitled "On new Species of Ephemeridæ from the Tenasserim Valley."

Linnean Society, March 17.—Prof. Stewart, President, in the chair.—Mr. E. M. Holmes exhibited specimens of *Phacelocarpus disciger*, a new species of seaweed from Cape Colony, collected by Dr. Becker near the mouth of the Kowie River. One of the specimens exhibited bore antheridia which have not previously been described in this genus. The species differs from those already known in bearing the organs of reproduction on the surface of the frond instead of on the margin.—Mr. Buxton Shillitoe exhibited and made some remarks upon the flowers of *Leucojum vernum* and *Helleborus viridis*.—On behalf of Mr. Allan Swan, the Secretary read a paper on the vitality of the spores of *Bacillus megatherium*, upon which criticism was offered by Mr. G. Murray.—Mr. S. B. Carlill submitted a paper entitled "Notes on Zebras," in which he discussed the position assigned to the zebra in the genus *Equus*; the use and nature of striped coats; the contention that the sallenders on the legs of the *Equidæ* represent the hoof of the first digit of their polydactyl ancestors; and the evidence bearing upon Prof. Owen's view that the cave horse was in some respects zebrine. He concluded by advocating a systematic attempt to domesticate one or more species of zebra for transport work. Domestication, he considered, would not only render these animals eminently useful, but would be the only means of preserving them from extinction.

Cambridge.

Philosophical Society, March 7.—Prof. G. H. Darwin, President, in the chair.—The following communications were made:—Some experiments on electric discharge, by Prof. Thomson. A series of experiments were shown in which the electric discharge took place in bulbs without electrodes. It was shown that the colour of the discharge through the same gas varied very greatly with the density of the gas and the intensity of the discharge. This was illustrated by two bulbs, each containing air; the discharge through one was a bright blue, and through the other an apple-green. Another experiment showed the gas at a very low pressure could not act as an electro-magnetic screen, though it did so at a higher pressure. The laws governing the absorption of energy by conductors placed near very rapidly alternating currents were illustrated by experiments which showed that there was much greater absorption of energy by small pieces of tin-foil than large masses of brass or copper.—The capture of Lexell's comet by Jupiter, by the President (Prof. Darwin). The paper contains a more exact estimation of the radius of the sphere of Jupiter's influence than that given by Laplace. If a comet come within this sphere, its orbit will be seriously transformed by the planet. The radius is estimated by the principle that at its boundary the effect of the perturbing force of Jupiter on an orbit round the sun is the same as the effect of the perturbing force of the sun on an orbit round Jupiter. The radius comes out to be ·058 times the distance of Jupiter from the sun, Laplace's approximation being ·054 times the same distance.—The change of zero of thermometers, by Mr. C. T. Heycock. The author described the result of experiments he had made in conjunction with Mr. Neville to overcome the change in zero which thermometers undergo when heated

for a long time. The method consisted in boiling the thermometers for eighteen days in baths of either mercury or sulphur; at the end of this time the zeros were found to be practically fixed unless they were exposed to higher temperatures than those of the substance in which they were boiled. The paper was illustrated by a curve showing that the change in zero was very rapid for the first few hours, amounting in a special case to 11° C. for twenty hours' heating, but that afterwards the change became almost *nil* as the heating was continued.—The elasticity of cubic crystals, by Mr. A. E. H. Love.—Changes in the dimensions of elastic solids due to given systems of forces, by M. C. Chree. Expressions are found for the mean values of the strains and stresses in any homogeneous elastic solid, whether æolotropic or isotropic, under the influence of any given system of bodily and surface forces. The expressions for the mean values of the strains, more especially of the dilatation, are employed in determining the changes in the dimensions of elastic solids in a variety of special cases. The effects of gravitational and centrifugal forces are more particularly considered.—On the law of distribution of velocities in a system of moving molecules, by Mr. A. H. Leahy. A short proof is given of the Maxwell law of distribution based upon the principle that a system of molecules, whose velocities are instantaneously reversed, will return to its former configuration. The limit which must be put to the least number of molecules in a gas if the ordinary assumptions of the kinetic theory of gases may be relied upon is also examined, and a note made on the evidence that a system of molecules will ultimately attain to a steady state of distribution.

EDINBURGH.

Royal Society, March 7.—Prof. Sir W. Turner, Vice-President, in the chair.—Prof. Cossar Ewart read a paper on the cranial nerves of man and Selachians. He compared the cranial nerves of the skate and shark genus with those of man, and discussed their probable identity. The facial nerve of the fish is much more developed than that of any other vertebrate, but is entirely sensory, while in man it is a motor nerve. In some mammals, though not in man, there are vestiges of the lateral sense-organs. These organs occur in the tadpole, but are practically absent in the fully-developed frog. It would seem, therefore, that the mammals originally possessed rudiments of these organs, but that these rudiments disappeared as development proceeded.

March 14.—The Rev. Prof. Flint, Vice-President, in the chair.—Mr. Robert Irvine read a communication, by Dr. John Murray and himself, on the changes in the chemical composition of sea-water associated with marine blue muds. The observations recorded were made on mud dredged from Granton Harbour and from the old quarry near Granton.—Dr. John Murray read a paper, by Mr. Irvine and himself, on manganese nodules in the marine deposits of the Clyde sea-area. Manganese occurs in great quantities in that area, and this forms a striking exception to the usual distribution of manganese as regards depth of water. Dr. Murray, therefore, in a previous paper on this subject, suggested that the large occurrence of manganese in the Clyde area had its origin in the waste products discharged into the river from the manufactories at Glasgow. During the past year a great many dredgings have been taken on the west coast of Scotland and in basins to the north of the Mull of Cantyre, with the result that very little manganese was found, while, as before, large quantities were obtained in the Clyde sea-area—so much so that it would almost pay to dredge it on the Skelmorlie Bank. Dr. Murray's explanation is therefore strongly confirmed.—Dr. Murray exhibited a specimen of extremely pure chalk from Christmas Island (about two hundred miles from the coast of Java).—Dr. Noel Paton read a paper on a case of the occurrence of crystalline globulin in urine.—Prof. Tait read an additional note on the isothermals of carbonic acid at volumes less than the critical volume.

March 21.—The Hon. Lord M'Laren in the chair.—The Keith Prize for the period 1889–91 was presented to Mr. R. T. Omond, Superintendent of the Ben Nevis Observatory, for his contributions to meteorological science; and the Makdougall-Brisbane Prize for 1888–90 was presented to Dr. Ludwig Becker for his paper on the solar spectrum at medium and low altitudes.—The Astronomer-Royal for Scotland made a further communication on *Nova Aurigæ*. The atmospheric conditions were remarkably favourable for observation until the 11th day of February, when the star was of the fifth magnitude, but since that time, until the 18th of this month, only occasional observations were possible. Between the 8th and the 18th no observations were obtained, and the star had meanwhile fallen from the sixth to the ninth magnitude. In the beginning of March it was fully 130 times as bright as it is at present. The spectrum is now nearly continuous throughout with traces of bright lines. Thus *Nova Aurigæ* presents closer analogies to *Nova Coronæ* than to *Nova Cygni*, in which an originally continuous spectrum with bright lines changed to a discontinuous spectrum presenting only one bright line close to one of the great nebular lines. One of the lines in *Nova Aurigæ* is very close to this nebular line, but there is reason to believe that it is due to a substance other than that which gives the nebular line.—Dr. R. H. Traquair read a paper on the fossil Selachii of Fife and the Lothians. Five new species are included.

GLASGOW.

Geological Society, March 10.—Mr. Dugald Bell read a paper on the alleged submergence in Scotland during the Glacial epoch, with special reference to the so-called "high-level shell-bed" at Chapelhall, near Airdrie, 512 feet above the sea. This "bed" had first been brought into notice by Mr. Smith, of Jordanhill, in a paper to the Geological Society in 1850, and had since been generally accepted as proving a submergence of the land to at least that extent. Its existence, however, rested on very imperfect evidence. It was said to have been found in digging a well near the summit of one of the high ridges of boulder-clay in the district; and was described as a bed of fine reddish clay, about 2 feet thick, and thinning away rapidly on all sides, lying in a hollow of the boulder-clay, which was 14 feet or more in thickness both above and below it. The well seems to have been built up before Mr. Smith had an opportunity of examining the section, though he got some shells said to have been found in the clay, and which were all of one species, *Tellina calcarea*. From that day to this no geologist had seen the clay, though it had been sought for all around, and though another well had been sunk within a few yards of the old one, in the hope of finding it. At the very utmost, it seems to have been a limited strip or patch of shelly clay, intercalated in the boulder-clay, such as had been found in many other localities, and could not fairly be taken as a sufficient proof of submergence. The more they were considered the greater seemed the improbabilities which the theory of a submergence and re-emergence of the country to this extent, and at that time, involved. There was not a particle of corroborative evidence. No shells had been found at a similar level in other parts of the midland valley, nor in the numerous side-valleys, where they would be more likely to be preserved than on this exposed knoll in the centre. None had been found in the upper boulder-clay, which, if all this valley had been a sea-bottom before the "second glaciation," should contain abundance of at least shelly fragments. Further, a "mild interglacial period" would probably accompany such a submergence, and this shelly clay was supposed to have been laid down during such a period; but the only species of shells found in it indicated, not mild, but extremely cold conditions. In face of all these difficulties, it was suggested that the layer containing these shells may have been transported (probably in a frozen condition) by the ice-sheet, as in many other instances that were well known. This seemed to be by far the more probable account of it, and got rid of the complications connected with a first glaciation, a deep submergence, a re-emergence, and a second glaciation closely resembling the first. The position of this patch of shelly clay, admittedly in the track of the old ice-sheet, and in front of an obstruction presented by the highest rising ground in the district; the highly Arctic character of the organisms; the very colour of the clay (as reported) being different from the clays of the immediate neighbourhood,—all favoured this conclusion. This Chapelhall clay, therefore, he submitted, ought no longer to be cited as a proof of submergence. An animated discussion followed.

PARIS.

Academy of Sciences, March 21.—M. d'Abbadie in the chair.—A study of the properties of amorphous boron, by M. H. Moissan. A full account is given of the physical and chemical properties of pure amorphous boron. The following conclusions are arrived at by the author:—Boron combines more readily with the metalloids than with the metals; it has a great affinity for fluorine, chlorine, oxygen, and sulphur. At a red heat it displaces silicon and carbon from their oxides. It

combines with nitrogen directly only at a very high temperature; it readily reacts with a large number of salts. Its action on metallic oxides, easily reduced by carbon, is very violent. (See p. 522.)—On the preparation of boron iodide, by M. H. Moissan.—On the origin of colouring matters in the vine; the ampelochroic acids and the autumnal coloration of vegetation, by M. Arm. Gautier.—Experiments on vascular reflex action, by M. L. Ranvier.—Contribution to the history of morbid associations: coexistence of stercorary retention with general diseases and injuries of the great visceræ, the kidneys in particular, by M. Verneuil.—Surface and population: European States, by M. Émile Levasseur. The following values have been taken from the tables given:—

States.	Surface, in thousands of square kilometres.	Population, in millions of inhabitants at the end of 1890.	Density, or number of inhabitants per square kilometre.
West Europe ...	916·32 ...	87·11 ...	95·0
Central „ ...	1207·56 ...	93·609 ...	77·0
South „ ...	1450·565 ...	71·826 ...	50·0
East „ ...	5477·0 ...	98·0 ...	18·0
North „ ...	983·0 ...	9·1 ...	9·0
Total ...	10,034·445 ...	359·645 ...	35·8

The methods of arriving at these numbers and other information relating to them are fully explained.—Report on a memoir, presented by M. Blondlot, on the propagation of Hertz vibrations.—Observations of comet *a* 1892 (Swift), made at the Paris Observatory with the West Tower equatorial, by M. G. Bigourdan.—Observations of comet *c* 1892, made at the Paris Observatory with the same instrument, by the same author.—Observations of Swift's comet (1892 March 6), made with the great equatorial of Bordeaux Observatory, by M. G. Rayet.—On the common periodicity of sun-spots and auroræ, by M. Terby. (For the last four communications see Our Astronomical Column.)—On the tensions of saturated vapours of different liquids at the same pressure, by M. Edmond Colot. The experiments made by the author bear out the law that between the temperatures t and θ of the saturated vapours of any two liquids which correspond to the same pressure, there exists the linear relation $t = A\theta + B$, where A and B are two constants, the values of which depend on the nature of the liquids under consideration.—On a standard condenser, by M. H. Abraham. With a view of making a new determination of v, M. Abraham has constructed an air condenser having a capacity of about 500 in electro-static C.G.S. units. The arrangement is described, and estimations are given of the probable accuracy which can be attained. The ratio of the electro-static to the electro magnetic unit (v) has not yet been found.—On electro-capillary phenomena, by M. Gouy.—On the manifestation of negative electricity during fine weather, by M. Ch. André. During fine weather a negative electrification of the air is extremely rare. Several theories have been put forward to account for this, but an examination of some of the records of atmospheric electricity, made at the Lyons Observatory, leads M. André to conclude that the appearance of negative electrification during fine weather is an exaggeration of a diurnal variation of which it is a particular case.—Crystalline absorption and the choice between the different theories of light, by M. E. Carvallo. If a ray of monochromatic light traverse a double-refracting crystal, the absorption only depends on the position of the Fresnel vibration. The intensity of the emergent ray is given by M. Becquerel's formula—

$$\sqrt{i} = \sqrt{i_0}(e^{-mx}\cos^2\alpha + e^{-nx}\cos^2\beta + e^{-px}\cos^2\gamma),$$

where i_0 is the intensity of the incident ray; i, the intensity of the emergent ray; α, β, γ, angles between Fresnel's vibration and the axes of optical elasticity; x, the thickness of the crystal traversed by the ray; and e, the base of Naperian logarithms. The author finds that this law is verified in the important case where only one of the three components exists. It also applies to heat rays. Finally, when an extraordinary ray traverses tourmaline in a direction oblique to the axis, its state of polarization varies progressively until the thickness traversed is that which would destroy the ordinary ray. This state then remains invariable up to emergence, when the ray sharply regains the state of original polarization.—On the determination of chemical equilibrium in solution systems, by M. Georges Charpy.—Combinations of cuprous iodide with ammonium thiosulphate, by M. E. Brun. The following compounds have been obtained: $Cu_2I_2 . 2NH_4I . 8(NH_4)_2S_2O_3$; $4Cu_2I_2 . Cu_2S_2O_3 . 7(NH_4)_2S_2O_3 . 4H_2O$; and $Cu_2I_2 . (NH_4)_2S_2O_3 . H_2O$. The author proposes to study similar compounds yielded by sodium and potassium thiosulphates, and also compounds given by other iodides, such as those of silver and lead.—Study of the velocity of decomposition of diazo compounds, by MM. J. Hausser and P. Th. Muller.—Some bases homologous with quinine, by MM. E. Grimaux and A. Arnaud.—The essence of *Licari kanali*, by M. Ph. Barbier.—Combinations of the fatty acids with the ethylene series of hydrocarbons, by MM. Béhal and Desgrez.—On the natural synthesis of the vegetable hydrocarbons, by M. Maquenne.—On the presence, in straw, of an aërobic ferment reducing nitrates, by M. E. Bréal.—On the hereditary transmission of acquired characters by *Bacillus anthracis* under the influence of a dysgenesic temperature, by M. C. Phisalix.—On the nitrogen in the blood, by MM. F. Jolyet and C. Sigalas.—Anatomy of the hypogastric nervous system of mammals, by M. Lannegrace.—On the Pliocene bird fauna of Roussillon, by M. Ch. Depéret.—The sickle at the end of the Stone Age, by M. Émile Cartailhac.—On the *régime* of artesian wells in the El Golea region, by M. Georges Rolland.—On a particular cause of contamination of water having its source in limestones, by M. E. A. Martel.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Travels amongst the Great Andes of the Equator, and Supplementary Appendix to ditto: E. Whymper (Murray).—Diagram Illustrating the Leblanc Soda Process, and Key to ditto: J. J. Miller (J. Heywood).—Dictionary of Political Economy: Edited by R. H. I. Palgrave, Part 2 (Macmillan).—Bibliothek des Professors der Zoologie und Vergl. Anatomie, 1891: Dr. L. von Graff (Leipzig, Engelmann).—The Universal Atlas, Part 13 (Cassell).—Le Climat de Rio de Janeiro: L. Cruls (Rio de Janeiro).—The World and the Flood: A. J. Stuart (Shanklin).

PAMPHLET.—The French Peasantry since the Revolution of 1789: L. Nottelle (Simpkin).

SERIALS.—Quarterly Journal of Microscopical Science, No. 131 (Churchill).—Bulletin de la Société Astronomique de France, cinq. année, 1891 (Paris).

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